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FINAL REMEDIAL INVESTIGATION REPORT FOR OPERABLE UNIT 1 (OU 1) NORTH GRINDER LANDFILL VOLUME 1 OF 2 CHAPTERS 1 THROUGH 8 APPENDICES A THROUGH F NTC ORLANDO FL

12/19/1996

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REMEDIAL INVESTIGATION REPORT
NORTH GRINDER LANDFILL
OPERABLE UNIT 1

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

VOLUME I: CHAPTERS 1.0 THROUGH 8.0
APPENDICES A THROUGH F

UNIT IDENTIFICATION CODE: N65928
CONTRACT NO.: N62467-89-D-0317/107

DECEMBER 1996

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010

ABB

December 19, 1996 8519.288

Commanding Officer
SOUTHNAVFACENGCOM
2155 Eagle Drive
N. Charleston, S.C. 29419-9010

Attn: **Ms. Barbara Nwokike, Code 187300**

Subject: NTC, Orlando, Operable Unit (OU) 1
Final Remedial Investigation Report
Contract; N62467-89-D-0317/CTO 107

Dear Barbara:

Enclosed please find copies of the subject document for your usage. This final document contains all USEPA and FDEP comment responses previously discussed and most recently accepted during our meeting on November 13, 1996. All data from supplemental investigations during 1996 are also included in the document.

Because the OU is a landfill with a preliminarily accepted remedy of a sampling and monitoring plan supplemented by deed restrictions, a Feasibility Study (FS) will not be preformed. Therefore, upon authorization to proceed, we will begin work on the Proposed Plan, Record of Decision, and the design aspects of the final remedy.

Should you have any questions regarding the document, or further actions at this OU; please call me at (407) 895-8845.

Very Truly Yours,
ABB ENVIRONMENTAL SERVICES, INC.

John Kaiser

John P. Kaiser
Installation Manager

Enc.

JK/cp
cc: W. Hansel (SDIV)
J. Mitchell (FDEP)
N. Rodriguez (EPA)
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February 18, 1997 8545.309

Commanding Officer
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N. Charleston, S.C. 29419-9010

Attn: **Ms. Barbara Nwokike, Code 187300**

Subject: NTC, Orlando Operable Unit 1 (OU1)
North Grinder Landfill
Remedial Investigation Report
Replacement Pages
Contract; N62467-89-D-0317/CTO 107

Dear Barbara:

The subject document was issued for use on December 19, 1996. By previous agreement, any changes would be accomplished by errata pages. Therefore, based on Florida Department of Environmental Protection (FDEP) comments dated January 17, 1997, the attached replacement pages are submitted. All holders of the subject document are requested to make the appropriate changes.

Please insert the professional certification page in Volume I after the Certification of Technical Data Conformity. The other two pages should be inserted, replacing the existing pages, in chapters six and eight, respectively.

Should you have any questions or need additional information, please call me at (407) 895-8845.

Very Truly Yours,
ABB ENVIRONMENTAL SERVICES, INC.

John Kaiser

John P. Kaiser
Installation Manager
Enc.

JK/cp
cc: W. Hansel (SDIV)
J. Mitchell (FDEP)
N. Rodriguez (EPA)
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S. McCoy (Brown & Root)

This Remedial Investigation Report, North Grinder Landfill, Operable Unit 1, for the Naval Training Center, Orlando, Florida (dated December 1996) has been prepared under the direction of a Florida-registered Professional Geologist. The work and professional opinions rendered in this document were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice.

P. Greg Mudd, P.G.

Professional Geologist
License No. 1521
Expires July 31, 1998

6.0 HUMAN HEALTH RISK ASSESSMENT (HHRA)

6.1 HHRA. An HHRA has been conducted as part of the RI completed for NTC, Orlando OU 1. The purpose of the HHRA is to characterize the human health risks associated with potential exposures to site-related contaminants in environmental media present at and migrating from the former North Grinder Landfill.

This section includes the characterization of the risks associated with potential exposures to site-related contaminants detected at OU 1 for human health receptors. This risk assessment is organized as follows: Section 6.1 includes seven subsections: Subsection 6.1.1 Data Evaluation; Subsection 6.1.2 Selection of Human Health Chemicals of Potential Concern; Subsection 6.1.3 Exposure Assessment; Subsection 6.1.4 Toxicity Assessment, and Subsection 6.1.5 Risk Characterization, including uncertainty analysis; Subsection 6.1.6 is the human health risk assessment summary; and following the risk assessment is a presentation of remedial goal options, Subsection 6.1.7. Appendices J-1 through J-9 provide documentation of various aspects of this risk assessment.

This HHRA is conducted in accordance with the USEPA's *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)* (USEPA, 1989a), Guidance for Data Useability in Risk Assessment (Part A), Final (USEPA, 1992a), Region IV Risk Assessment Guidance (USEPA, 1995a) and will consider FDEP guidance, particularly, Soil Cleanup Goals for Florida (FDEP, 1995), FDEP Drinking Water Standards (FDEP, 1994) and numerous other USEPA guidance documents and directives (USEPA, 1986a, 1989b, 1991a, 1992b, 1992c, 1992d). The HHRA is conducted to determine if contamination at the North Grinder Landfill (OU 1) poses potential health risks of concern to individuals under current and/or foreseeable future site conditions in the absence of remediation. The HHRA consists of several components: data evaluation, identification of CPCs, exposure assessment, toxicity assessment risk characterization (including uncertainty analysis) (USEPA, 1989a), a risk assessment summary, and discussion of remedial goal options. Collectively, these components are used to identify site-related contaminants and estimate the potential magnitude of exposure and the risks resulting from the estimated exposure conditions. An overview of the technical approach to be used in the NTC, Orlando OU 1 HHRA is presented here.

The location, physical description, and history associated with the North Grinder Landfill are described in Section 1.2. Surface soil and groundwater samples were collected during the RI (Section 2.2). After evaluation and management of the environmental data collected at the North Grinder Landfill (Chapter 2.0), HHCPCs were selected and the potential human health risks associated with each medium at the North Grinder Landfill were characterized.

6.1.1 Data Evaluation The data evaluation involves numerous activities: sort data by medium, evaluate analytical methods, evaluate quantitation limits, evaluate quality of data with respect to qualifiers and codes, evaluate tentatively identified compounds, compare potential site-related contamination with background, develop data set for use in risk assessment, and identify CPCs. After a brief summary of the sampling and analysis activities conducted to date is presented, a description of each of these activities is provided below.

Available Data. A thorough discussion of all data collection activities and a presentation of the analytical data are provided in the previous sections of this RI report and its appendices. The available analytical data for OU 1 consist of landfill cover (referred to as surface soil) and groundwater sampling and analytical results.

6.1.1.1 Evaluate the Analytical Methods A detailed discussion of the analytical methods employed in developing analytical environmental data is presented in the RI report. The data used in this risk assessment will be the result of analyses conducted under the CLP with documented QA/QC procedures. The analytical data will be further evaluated for useability in the quantitative risk assessment evaluating quantitation limits, evaluating qualified and coded data, comparing concentrations detected in samples to concentrations detected in blanks, and by evaluating tentatively identified compounds (TICs).

6.1.1.2 Evaluate Quantitation Limits Sample quantitation limits (SQLs) are compared to Federal RBCs and State SCGs for soil. SQLs are also compared to Federal MCLs, Florida Drinking Water Standards, and Florida Groundwater Guidance Concentrations for groundwater. Analyte-specific SQLs that are above RBCs are identified so that uncertainties in risk estimates for those analytes can be discussed.

The notable situations where the highest reported SQLs exceed an RBC for residential soil or a Florida residential SCG include benzo(a)pyrene and dibenz(a,h)anthracene (highest reporting limit 350 μg/kg) with RBCs and SCGs of 88 μg/kg and 100 μg/kg, respectively. The highest reporting limit for Aroclor-1260 in soil was 180 μg/kg, which is higher than the residential RBC of 83 μg/kg but below the Florida SCG of 900 μg/kg. From a risk or regulatory perspective, SQLs are adequate to ensure that concentration of concern could be detected and qualified.

The Basewide Environmental Baseline Survey and the Record of Decision between the Navy and the Orlando Community Redevelopment Authority indicate reuse of the property for recreational purposes. This proposed reuse is within acceptable risks for soil and will be required through a restrictive covenant.

6.1.1.3 Evaluate Qualified and Coded Data Both the laboratory and data validators may assign qualifiers to analytical results. The qualifiers assigned by the data validators supersede the laboratory qualifiers. The results of the data validation will be discussed in the RI report, and the validated data, with qualifiers, are presented in Appendices to that report. All positive detections (whether they are unqualified or qualified with a "J") have been considered detected concentrations for the risk assessment. All nondetects (qualified with a "U") will be retained in the risk assessment data set as samples without positive detections. If all sample results for a given analyte in a given medium are nondetects, then that analyte will not be retained as a detected analyte for the purposes of the risk assessment. Any sample results with an "R" validation qualifier will be eliminated from the risk assessment data set because quality control indicates that the result is unusable.

6.1.1.4 Compare Concentrations Detected in Samples to Concentrations Detected in Blanks Sample concentrations have been compared to the concentrations in associated blanks in order to distinguish artifacts from actual presence of analytes in environmental samples. The comparisons will be conducted as part of constituents. Specific radionuclides selected for analysis were based on most probable sources (radium paint and natural sources), and included major contributors in the uranium-238 series, potassium-40, and cesium-137.

There is significant evidence that supports the hypothesis that naturally occurring radionuclides associated with phosphates of the Hawthorn Group are being mobilized by anaerobic microbial activity at that depth. Of the radionuclides scanned, the significant contributions are from members of the naturally occurring uranium-238 series and potassium-40, which suggests that the remaining contributors are likely naturally occurring radionuclides as well.

8.2.2 Fate and Transport Elevated (above background or MCL) gross alpha and/or beta were detected in groundwater samples from intermediate to deep monitoring wells located adjacent to the perimeter of the landfill. This has lead ABB-ES to conclude that the radiological contamination is due to mobilization of naturally occurring radionuclides rather than to buried radioactive material in the landfill. The natural uranium-238 series radioisotopes, which are known to be associated with the phosphates of the Hawthorn deposits, appear to be mobilized in the vicinity of the landfill and do not occur farther downgradient.

This mobilization is best explained by a change in groundwater chemistry due to indigenous bacteria enhancement by the landfill leachate. The organics in the leachate are transported by a steep downward hydraulic head differential in the southwest corner of the landfill. The leachate enhances the activity and density of bacteria in the basal zone of the surficial aquifer, and the redox potential decreases. As long as the landfill produces leachate, the reducing conditions created by the microorganisms will continue to reduce minerals of the Hawthorn deposits, and the radionuclides associated with these compounds will continue to be mobilized into the aquifer. Eventually, as the landfill ages and as fresh groundwater moves through, the groundwater chemistry below the landfill will return to background concentrations.

Farther downgradient from the landfill, the leachate is diluted and the bacteria density is normal. As the low Eh groundwater mixes with oxygenated groundwater, forming uranyl complexes, which are readily sorbed on colloidal particles such as organics, ferric hydroxides, and clays, radionuclides are largely precipitated out of solutions, reducing radionuclide activity below levels of concern. It appears that natural processes controlling groundwater Eh are preventing downgradient migration of the mobilized radionuclides. Therefore, downgradient surface water bodies, such as Lake Spier and Lake Berry, are apparently not threatened by elevated radionuclides at the landfill.

8.2.3 Risk Assessment A risk assessment was not performed for groundwater because no receptors were identified for either current or future use of the landfill, since no potable drinking water wells are in place or will be installed in the future. However, maximum detected groundwater concentrations were compared to FDEP Drinking Water Standards. This comparison indicated that groundwater is unsuitable as a source of drinking water and, therefore, institutional controls to prevent such use are required.

8.3 CONCLUSIONS. ABB-ES concludes the information below from the data gathered during this RI:

- Elevated levels of PAHs in surface soil analytical results from three adjacent samples in the east-central portion of the landfill pose cancer risks that are well within the levels of risk acceptable to the USEPA and are consistent with industrial SCGs for Florida.

- Elevated gross alpha and beta radiological activity is likely due to natural sources that are being mobilized by altered groundwater chemistry under the landfill and at its fringes. With sufficient institutional controls in place (deed restrictions, cover maintenance), future users of the property will not be exposed to groundwater with elevated radiological parameters; therefore, no risk will be incurred.

- A landfill cap will not be required because surface soil contamination is within acceptable risks with a restrictive covenant required to ensure the proposed reuse as recreational.

- A groundwater monitoring program for downgradient wells to observe changes in groundwater contaminants as a function of time is recommended.

REMEDIAL INVESTIGATION REPORT
NORTH GRINDER LANDFILL
OPERABLE UNIT 1

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

Unit Identification Code: N65928

Contract No.: N62467-89-D-0317/107

Prepared by:

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Prepared for:

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Barbara Nwokike, Code 1873, Engineer-in-Charge

December 1996

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, ABB Environmental Services, Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0317/107 are complete and accurate and comply with all requirements of this contract.

DATE: December 20, 1996

NAME AND TITLE OF CERTIFYING OFFICIAL: John Kaiser
Task Order Manager

NAME AND TITLE OF CERTIFYING OFFICIAL: Richard Allen
Project Technical Lead

(DFAR 252.227-7036)

FOREWORD

To meet its mission objectives, the U.S. Navy performs a variety of operations, some requiring the use, handling, storage, or disposal of hazardous materials. Through accidental spills and leaks and conventional methods of past disposal, hazardous materials may have entered the environment in ways unacceptable by today's standards. With growing knowledge of the long-term effects of hazardous materials on the environment, the Department of Defense (DOD) initiated various programs to investigate and remediate conditions related to suspected past releases of hazardous materials at their facilities.

One of these programs is the Base Realignment and Closure (BRAC) Cleanup Plan (BCP). This program complies with the Base Closure and Realignment Act of 1988 (Public Law 100-526, 102 Statute 2623) and the Defense Base Closure and Realignment Act of 1990 (Public Law 101-510, 104 Statute 1808), which require the DOD to observe pertinent environmental legal provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Executive Order 12580, and the statutory provisions of the Defense Environmental Restoration Program, the National Environmental Policy Act (NEPA), and any other applicable statutes that protect natural and cultural resources.

CERCLA requirements, in conjunction with corrective action requirements under Subtitle C of the Resource Conservation and Recovery Act (RCRA), govern most environmental restoration activities. Requirements under Subtitles C, I, and D of RCRA, as well as the Toxic Substances Control Act, the Clean Water Act, the Clean Air Act, the Safe Drinking Water Act, and other statutes, govern most environmental mission-related, operational-related, and closure-related compliance activities. These compliance laws may also be applicable or relevant and appropriate requirements for selecting and implementing remedial actions under CERCLA. NEPA requirements govern the Environmental Impact Analysis and Environmental Impact Statement preparation for the disposal and reuse of BRAC installations.

The BCP process centers on a single goal: expediting and improving environmental response actions to facilitate the disposal and reuse of a BRAC installation, while protecting human health and the environment.

The Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), the U.S. Environmental Protection Agency, and the Florida Department of Environmental Protection (FDEP) collectively coordinate the cleanup activities through the Orlando Partnering Team. This team approach is intended to foster partnering, accelerate the environmental cleanup process, and expedite timely, cost-effective, the environmentally responsible disposal and reuse decisions.

Questions regarding the BCP process at Naval Training Center (NTC), Orlando should be addressed to the SOUTHNAVFACENGCOM BRAC Environmental Coordinator for NTC, Orlando, Mr. Wayne Hansel at (407)646-5294 or the Southern Division Engineer-in-Charge, Ms. Barbara Nwokike at (803)820-5566.

EXECUTIVE SUMMARY

The Navy has two programs to investigate and remediate conditions related to past releases of hazardous materials at its facilities. They are the Installation Restoration (IR) and Base Realignment and Closure (BRAC) programs. The IR program is conducted in several stages starting with a Preliminary Assessment (PA), which is followed by a site Inspection (SI). If needed, these initial studies are followed by a Remedial Investigation and Feasibility Study (RI/FS), and Remedial Design and Remedial Action (RD/RA).

The goal of the BRAC program is to expedite and improve environmental response actions to facilitate the disposal and reuse of a BRAC installation, while protecting human health and the environment. The BRAC program embraces the principles of the IR program, but is designed primarily as a vehicle for the transfer of former Navy property into the private sector in an environmentally responsible manner.

The first two stages of investigation at the North Grinder Landfill under the IR program (PA and SI) are represented by the Initial Assessment Study (IAS), completed by C.C. Johnson & Associates, Inc. (1985), and the Verification Study by Geraghty & Miller, Inc. (1986). The IAS consisted of field inspections, personnel interviews, and a review of historical records and aerial photographs, resulting in the identification of nine potentially contaminated sites at Naval Training Center (NTC), Orlando, including the North Grinder Landfill.

The verification study consisted of the installation of four water table monitoring wells (one upgradient, and three downgradient locations) and analysis of groundwater samples from those wells. Samples were submitted for analyses for volatile organic compounds (VOCs), metals, pesticides and polychlorinated biphenyls (PCBs), and radionuclides (gross alpha and gross beta). One of the downgradient monitoring wells had an exceedance for arsenic (68 micrograms per liter [$\mu g/\ell$] vs. a Federal maximum contaminant level [MCL] of 50 $\mu g/\ell$). All four monitoring wells had elevated levels of gross radioactivity (gross alpha from 20 to 41 picocuries per liter (pCi/ℓ) vs. a Florida MCL of 15 pCi/ℓ, and gross beta from 28 to 38 pCi/ℓ.

This Remedial Investigation (RI) represents the third stage of study at the North Grinder Landfill and was conducted under the BRAC program. A workplan to conduct an RI/FS was written and finalized by ABB Environmental Services, Inc. (ABB-ES) in March 1995. The workplan has incorporated concepts promulgated by the Superfund Accelerated Cleanup Model (SACM) program, developed by the U.S. Environmental Protection Agency to streamline and standardize environmental investigations. One of the concepts of SACM adopted for this investigation was the principle of the presumptive remedy. The presumptive remedy is a tool designed to ensure consistency in remedy selection and reduce the cost and time required to clean up similar types of sites. The presumptive remedy for municipal landfills begins with the assumption that the landfill will remain a landfill (i.e., removal is not an option that is considered) and that the only feasible alternative is containment, which includes:

- capping,
- leachate collection and treatment,

- landfill gas treatment, and
- institutional controls.

The field investigation was designed to be as efficient as possible to effect a rapid data acquisition and evaluation process. To this end, investigators began with the understanding that it would not be possible to completely characterize the site with even a very large number of explorations and chemical analyses. The approach was to sufficiently characterize the site with a limited number of explorations and chemical analyses that would permit development and refinement of a conceptual model based on reasonable conclusions drawn from those data.

The field investigation started in March 1995 with a geophysical survey to determine the footprint of the landfill and locate any "hot spots" that might warrant source removal. Following the geophysics, a passive soil gas survey took place over the landfill footprint to evaluate the existing soil cover. Permanent soil vapor implants were installed around the perimeter of the landfill to monitor whether or not landfill gas migration was taking place. Direct push technology (DPT) surveys took place to screen more than 150 groundwater samples taken from strategic locations both up- and downgradient from the landfill to facilitate the selection of permanent monitoring wells. Nine monitoring well clusters of three wells each (water table, intermediate depth, and base of surficial aquifer) were installed at locations upgradient, along the sides, and downgradient of the landfill. Five of the nine clusters were sited to evaluate two zones of minor VOC contamination in groundwater resulting from DPT screening studies. In addition, surface soil sampling at a frequency of one sample per acre took place over the landfill to evaluate the adequacy of landfill cover materials.

Surface soil and groundwater sampling analytical results have revealed two potential contaminant problems at the landfill:

- polyaromatic hydrocarbons (PAHs) in surface soils, and

- elevated radiological parameters in groundwater from several monitoring wells.

Surface soil analytical results revealed that out of a total of 14 samples, 3 adjacent samples in the east-central portion of the landfill had elevated levels of three PAHs. A human health risk evaluation indicates that the cancer risk from human exposure to these levels of contamination poses risks that are well within the levels of risk acceptable to the U.S. Environmental Protection Agency, but slightly exceed the cancer risk level established by the State of Florida.

Of the 27 monitoring wells that were sampled, elevated gross alpha and gross beta were observed in two intermediate and three deep groundwater samples. All of the wells in question are adjacent to the mapped perimeter of the landfill. Resampling and reanalysis has confirmed the elevated radiological parameters, but has left certain data gaps which are discussed in Chapter 4.0, Nature and Extent of Contamination. A second resampling event for certain field parameters and analysis for methane and volatile suspended solids in selected wells have led ABB-ES to conclude that the radiological activity is likely due to natural sources that are being mobilized by altered groundwater chemistry under the landfill and at its fringes.

Even though the radiological activity in certain intermediate and deep wells exceeds background levels measured in water table wells installed during the background study (ABB-ES, 1995a), the gross alpha levels observed are statistically in the same population as wells in the Florida Department of Environmental Protection's (FDEP's) data base within the St. Johns River Water Management District (gross beta levels are in two different populations). With sufficient institutional controls in place (deed restrictions, cover maintenance), future users of the property will not be exposed to groundwater with elevated radiological parameters; therefore, no risk will be incurred. A groundwater monitoring program of existing wells is recommended.

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<u>GLOSSARY</u>

ABB-ES	ABB Environmental Services, Inc.
ARAR	applicable or relevant and appropriate requirements
BHC	benzene hexachloride
bls	below land surface
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAG	Carcinogenic Assessment Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH_4	methane
CLP	Contract Laboratory program
CO_2	carbon dioxide
CPC	chemical of potential concern
CPT	cone penetrometer test
CRQL	contract-required quantitation limit
CSF	cancer slope factor
DCA	dichloroethane
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DERP	Defense Environmental Restoration Program
DO	dissolved oxygen
DOD	Department of Defense
DON	Department of Navy
DPT	direct push technology
DQO	data quality objective
°F	degrees Fahrenheit
ECD	electron capture detector
Eh	oxidation-reduction potential
ELCR	excess lifetime cancer risk
EPC	exposure point concentrations
ERA	ecological risk assessment
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FGFWFC	Florida Game and Freshwater Fish Commission
FID	flame ionization detector
FNAI	Florida Natural Areas Inventory
FS	feasibility study
ft^2/day	square feet per day
ft/ft	feet per foot
ft/min	feet per minute

GC	gas chromatograph
g/d/ft	gallons per day per foot
GPR	ground penetrating radar
GPS	Global Positioning System
HEAST	Health Effects Assessment Summary Tables
HHCPC	human health chemicals of potential concern
HHRA	human health risk assessment
HI	hazard index
HNu	HNu, Inc.
HQ	hazard quotient
HRS II	Hazard Ranking System II
IAS	initial assessment study
IR	Installation Restoration
IRIS	Integrated Risk Information System
ℓ/min	liters per minute
LNAPL	light nonaqueous-phase liquid
LOAEL	lowest observed adverse effect level
LOEC	lowest observed effects concentrations
MAC	Military Airlift Command
MCL	maximum contaminant level
$\mu\ell$	microliters
μg/kg	micrograms per kilogram
μg/mℓ	micrograms per milliliter
μg/ℓ	micrograms per liter
mg/ℓ	milligrams per liter
mg/cm^2	milligrams per square centimeter
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
mℓ	milliliter
msl	mean sea level
NACIP	Naval Assessment and Control of Installation Pollutants
NAD	North American Datum
NAS	National Academy of Sciences
NCP	National Oil and Hazardous Substances Contingency Plan
NEPA	National Environmental Policy Act
NOAEL	no observed adverse effect level
NRC	National Research Council
NTC	Naval Training Center
OAFB	Orlando Air Force Base
OU	operable unit

PA	preliminary assessment
PAH	polyaromatic hydrocarbon
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyls
PCE	perchloroethylene
PEF	particulate emission factor
pCi/ℓ	picocuries per liter
PCL	protective contaminant levels
POP	Project Operations Plan
ppb	parts per billion
psi	pounds per square inch
PVC	polyvinyl chloride
QA/QC	quality assurance and quality control
®	registered trademark symbol
RAGS	risk assessment guidance for Superfund
RAS	routine analytical services
RBC	risk-based concentration
RD/RA	remedial design and remedial action
RfC	reference concentration
RfD	reference dose
RGO	remedial goal options
RI	remedial investigation
RI/FS	remedial investigation and feasibility study
RME	reasonable maximum exposure
SACM	Superfund Accelerated Cleanup Model
SCG	soil cleanup goal
SI	site inspection
SM	service mark
SOUTHNAVFAC-ENGCOM	Southern Division, Naval Facility Engineering Command
SPT	standard penetration test
SQL	sample quantitation limit
SVOC	semivolatile organic compound
TAL	target analyte list
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethene
TCL	target compound list
TDS	total dissolved solids
TEF	toxicity equivalence factor
TIC	tentatively identified compound
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TSS	total suspended solids

GLOSSARY (Continued)

UCL	upper confidence limit
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
VOA	volatile organic aromatic
VOC	volatile organic compounds
VSS	volatile suspended solids

1.0 INTRODUCTION

1.1 REGULATORY BACKGROUND AND PURPOSE. To meet its mission objectives, the U.S. Navy performs a variety of operations, some requiring the use, handling, storage, or disposal of hazardous materials. Through accidental spills and leaks and conventional methods of past disposal, hazardous materials may have entered the environment in ways unacceptable by today's standards. With growing knowledge of the long-term effects of hazardous materials on the environment, the Department of Defense (DOD) initiated various programs to investigate and remediate conditions related to suspected past releases of hazardous materials at their facilities. Two of these programs are the Installation Restoration (IR) program and the Base Realignment and Closure (BRAC) program.

The IR program complies with the Base Closure and Realignment Act of 1988 (Public Law 100-526,102 Statute 2623) and the Defense Base Closure and Realignment Act of 1990 (Public Law 101-510, 104 Statute [1808]), which require the DOD to observe pertinent environmental legal provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Executive Order 12580, and the statutory provisions of the Defense Environmental Restoration Program (DERP), the National Environmental Policy Act (NEPA), and any other applicable statutes that protect natural and cultural resources.

Originally, the Navy's part of this program was called the Naval Assessment and Control of Installation Pollutants (NACIP) program. Early reports reflect the NACIP process and terminology. The Navy eventually adopted the program structure and terminology of the standard IR program.

The IR program is conducted in several stages as follows:

- Preliminary Assessment (PA),
- A Site Inspection (SI) (formerly the PA and SI steps were called the Initial Assessment Study [IAS] under the NACIP program),
- Remedial Investigation and Feasibility Study (RI/FS),
- Record of Decision, and
- Remedial Design and Remedial Action (RD/RA).

The goal of the BRAC program is to expedite and improve environmental response actions to facilitate the disposal and reuse of a BRAC installation, while protecting human health and the environment.

Several investigations have been performed at the Naval Training Center (NTC) in Orlando, Florida, to assess and characterize potential contamination at the facility. These include the 1985 IAS (C.C. Johnson, 1985), the followup 1986 Verification Study (Geraghty & Miller, 1986), and a U.S. Environmental Protection Agency (USEPA) Hazard Ranking System II (HRS II) Scoring (ABB Environmental Services, Inc. [ABB-ES], 1992). Under BRAC, an Environmental Baseline Survey (ABB-ES, 1994a) and various site investigations have been completed (ABB-ES, 1995b, 1995c).

The North Grinder Landfill was identified in the IAS and designated Operable Unit (OU) 1 for the purposes of this remedial investigation (RI). The RI was conducted to:

- determine the nature and distribution of contaminants at the site;
- identify potential threats to public health or the environment posed by the potential release of contaminants from the site; and
- support the evaluation of potential remedial alternatives based on engineering factors, implementability, environmental and public health concerns, and costs during the feasibility study (FS).

For this investigation, the presumptive remedy of containment has been assumed. It was anticipated that additional technologies would need to be considered to meet overall remedial objectives for the site. Presumptive remedies are preferred technologies for common categories of sites, based on historical RI/FS investigations within the Superfund program. The presumptive remedy approach is one tool of acceleration within the Superfund Accelerated Cleanup Model (SACM) and is expected to ensure consistency in remedy selection and reduce the cost and time required to clean up similar types of sites.

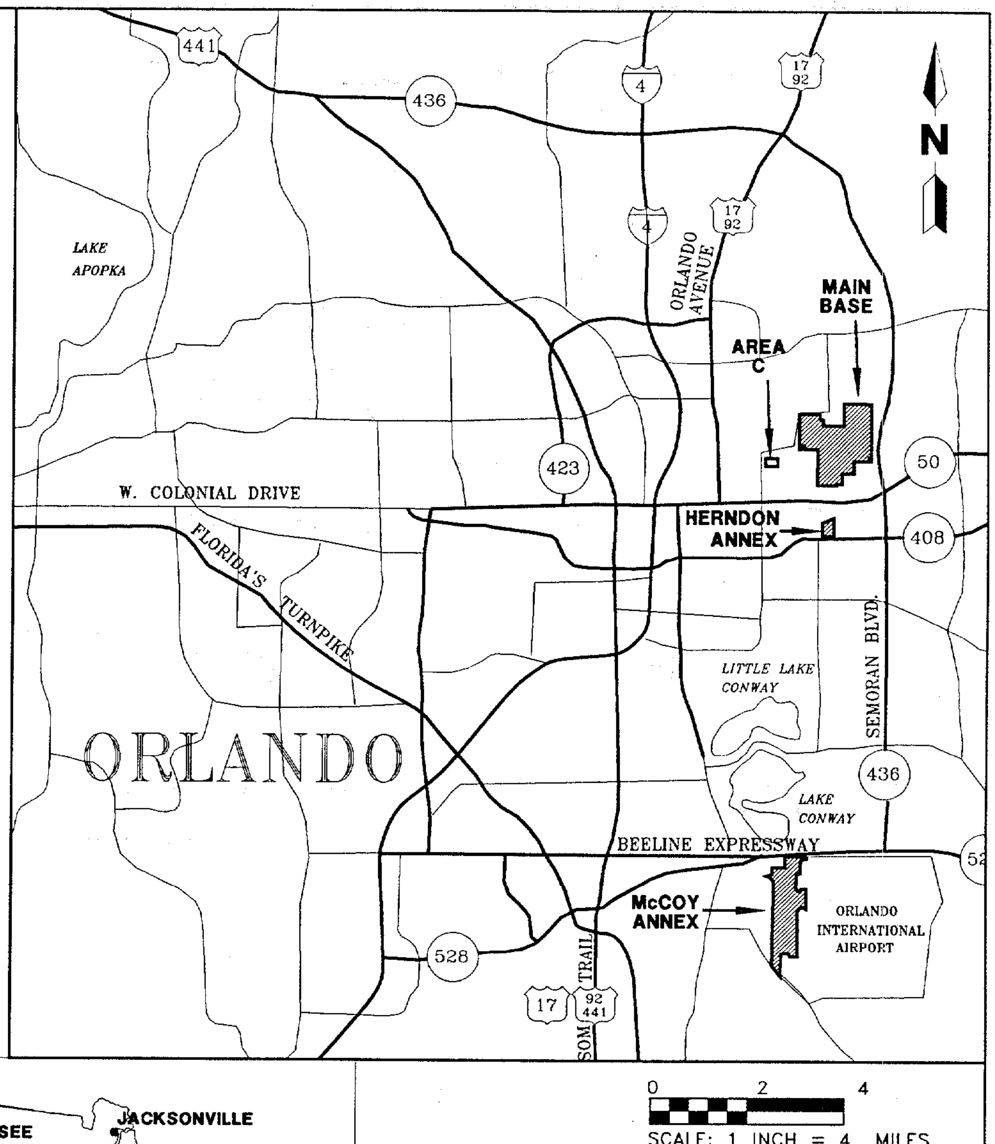
At the North Grinder Landfill, because a presumptive remedy of containment has been assumed, the primary goal of this RI is to determine (1) if groundwater controls are needed to prevent groundwater migration and (2) the type of cover that may be required to prevent exposure. To support decisions made as a result of this investigation, data have been acquired that will support a human health risk assessment, a qualitative ecological risk evaluation, and a feasibility study.

This RI report presents the results of these investigations.

<u>1.2 **FACILITY BACKGROUND**</u>. NTC, Orlando encompasses 2,072 acres in Orange County, Florida, and consists of four noncontiguous facilities: Main Base, Area C, Herndon Annex, and McCoy Annex (Figures 1-1 and 1-2). The Main Base occupies 1,095 acres and is located approximately 3 miles east of Interstate 4 and north of State Road 50. Area C is located approximately 1 mile west of the Main Base and occupies 45.8 acres. Herndon Annex (approximately 54 acres) is located 1.5 miles south of the Main Base, adjacent to the city of Orlando's Herndon Executive Airport. McCoy Annex is approximately 12 miles south of the Main Base, adjacent to the city of Orlando's International Airport. McCoy Annex occupies approximately 826 acres.

OU 1 is located on the Main Base and was operated as a landfill from its beginnings possibly as early as 1939 until it was closed in 1967. The following background information focuses on this portion of NTC, Orlando. Further discussions of Area C, Herndon Annex, and McCoy Annex may be found in the Project Operations Plan (POP) (ABB-ES, 1994b).

<u>1.2.1 **Facility History**</u> The history of NTC, Orlando dates to the construction of the original Orlando Municipal Airport prior to 1940. In August 1940, the municipal airport was taken over by the U.S. Army Air Corps. Shortly thereafter,



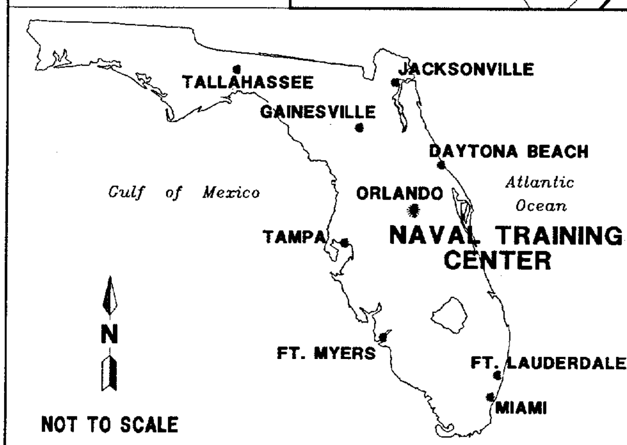


FIGURE 1-1
VICINITY MAP

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

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ORLANDO, FLORIDA

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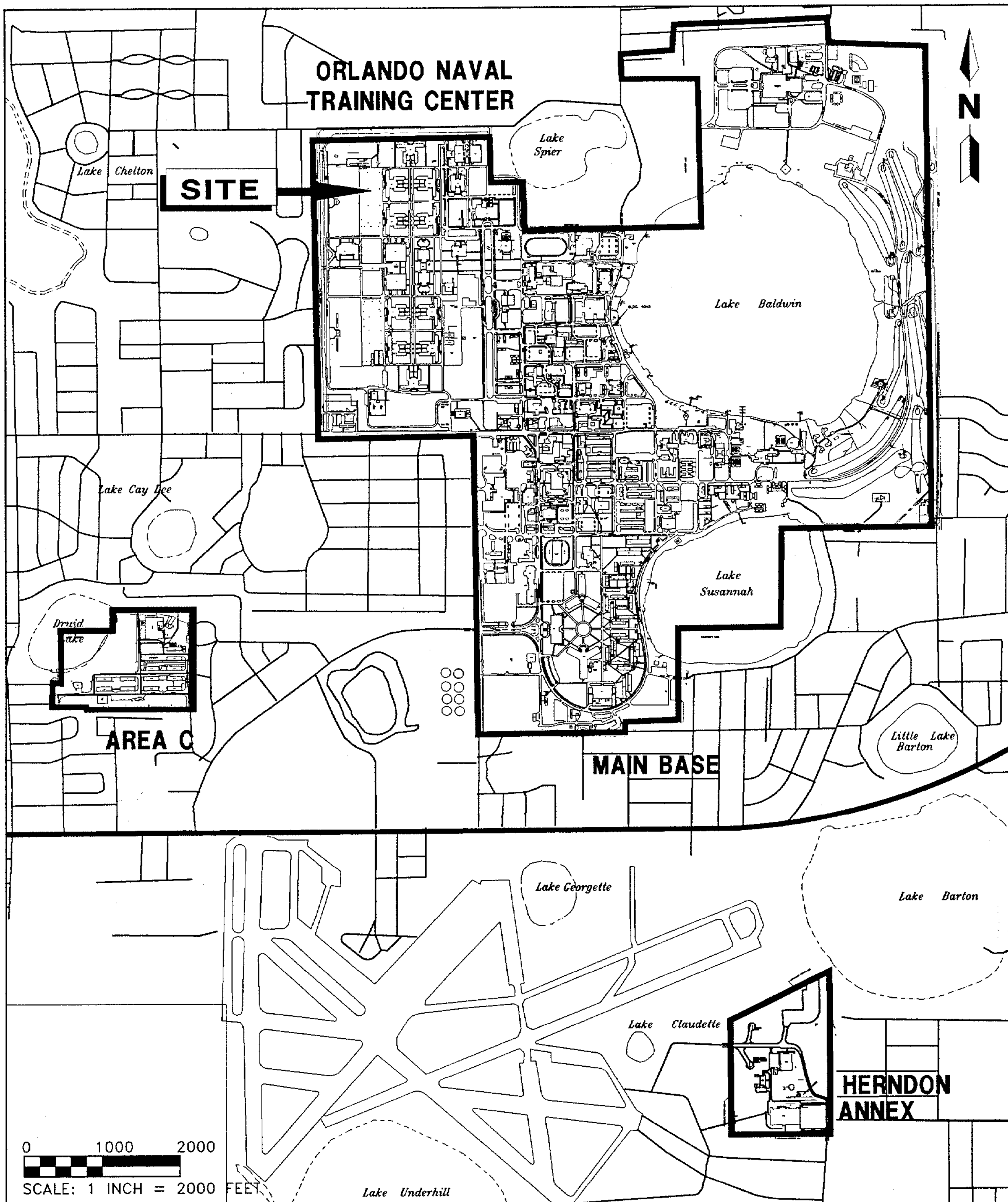

FIGURE 1-2
MAIN BASE, HERNDON ANNEX, AND AREA C SITE LOCATION MAP

REMEDIAL INVESTIGATION OPERABLE UNIT 1

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the construction program for Orlando Air Base began, culminating in its official opening on December 1, 1940. During the following 2 years, the Army Air Corps acquired additional property, and auxiliary landing fields were built in the surrounding area. The U.S. Army Air Corps conducted operations at the Main Base and Area C from 1940 to 1947.

In 1947, the U.S. Air Force assumed command of the facilities as the Orlando Air Force Base (OAFB). The base was deactivated on October 28, 1949, and remained on standby status until January 1, 1951, when it was reactivated as an Aviation Engineers' training site. Other Air Force units arrived, and the Military Airlift Command (MAC) assumed full jurisdiction of the base in 1953.

The Navy began moving its Training Device Center from Port Washington, New York, to OAFB on September 15, 1965, and finished the move in June 1967. In 1968, the Air Force ceased operations at OAFB, Area C, and Herndon Annex. The property was commissioned as the Naval Training Center, Orlando on July 1, 1968.

1.2.2 Facility Description The following paragraphs address operations and surrounding land use for the Main Base. Main Base operations constantly change, as various portions of NTC, Orlando gradually phase out activities.

1.2.2.1 **Facility Operations** The stated mission of NTC, Orlando is to exercise command over, and coordinate the efforts of, the assigned subordinate activities in recruit training of enlisted personnel; provide initial skill, advanced, and/or specialized training for officer and enlisted personnel of the regular Navy and Naval Reserve; and to support other activities as directed by a higher authority (ABB-ES, 1996).

The Main Base is composed primarily of operational and training facilities, including barracks, administrative buildings, drill fields, and recreational areas. These facilities were used to train new and recently graduated recruits, and today continue to train enlisted and officer personnel in the nuclear power engineering program (ABB-ES, 1995d).

1.2.2.2 **Adjacent Land Use** The Main Base is surrounded by urban development, including single and multifamily housing, schools, and commercial buildings. Land uses directly west and northeast of the area are primarily residential. The Glenridge Elementary School is located on Glenridge Road, approximately 1,000 feet due north of OU 1. Small areas of commercial development occur to the southwest. Herndon Airport is located 1.5 miles south of the Main Base. No industrial facilities exist adjacent to the Main Base, with the exception of automotive repair facilities along Bennett Road on the southwest property line (ABB-ES, 1994b).

1.2.3 North Grinder Landfill Description The North Grinder Landfill (Figure 1-3) is located in the northwest corner of the Main Base and is under both lawn and an asphalt paved area known as the "grinder" parade area (there is also a South Grinder parade area that will be discussed below). The North and South Grinder parade areas are flat, although topography drops in elevation west, north, and east of the sites.

The North Grinder Landfill appears on aerial photographs as a southwest to northeast "slash" composed of several trenches (Figure 1-4). Aerial photographs

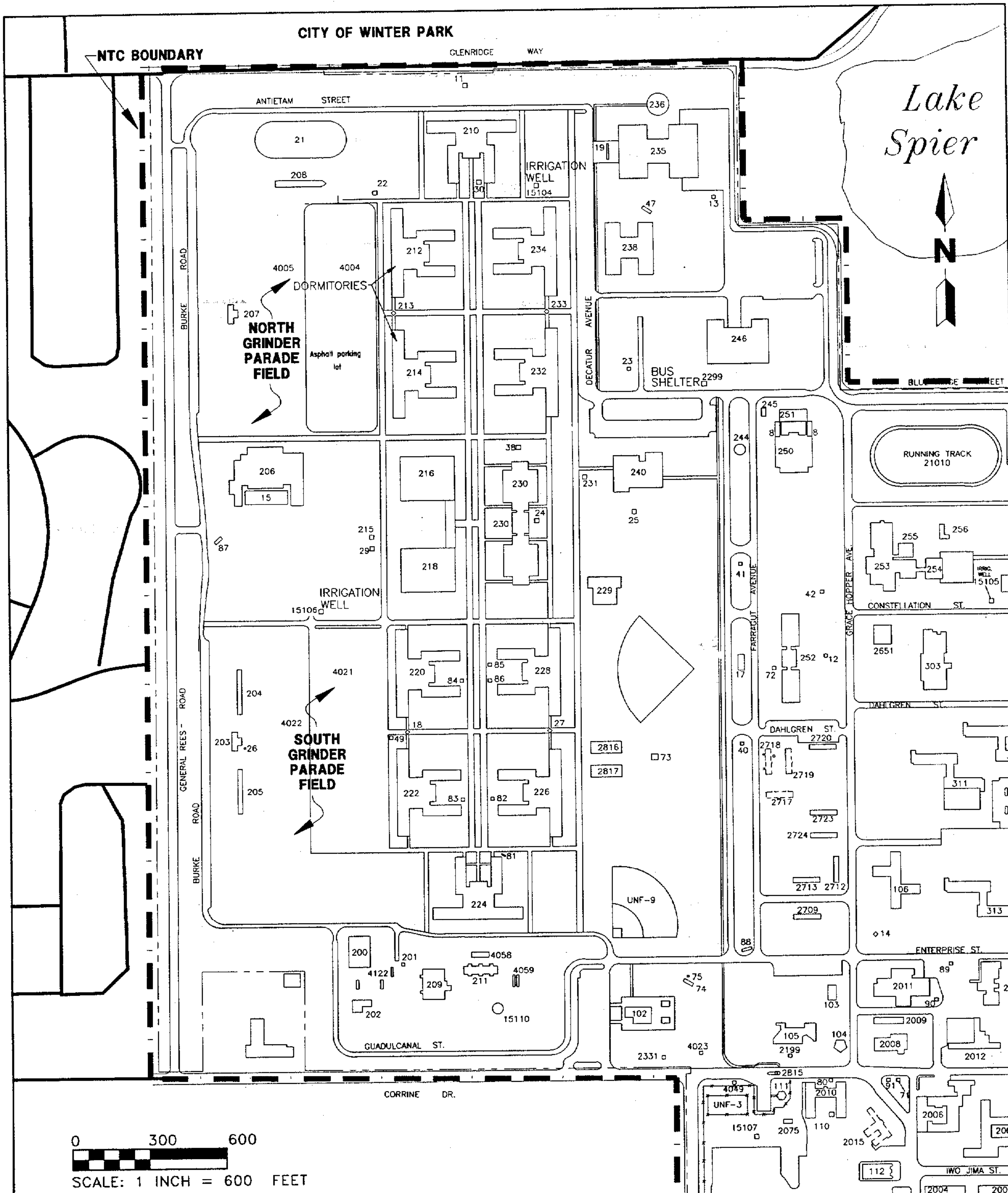

FIGURE 1-3
NORTH GRINDER AREA LOCATION MAP

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

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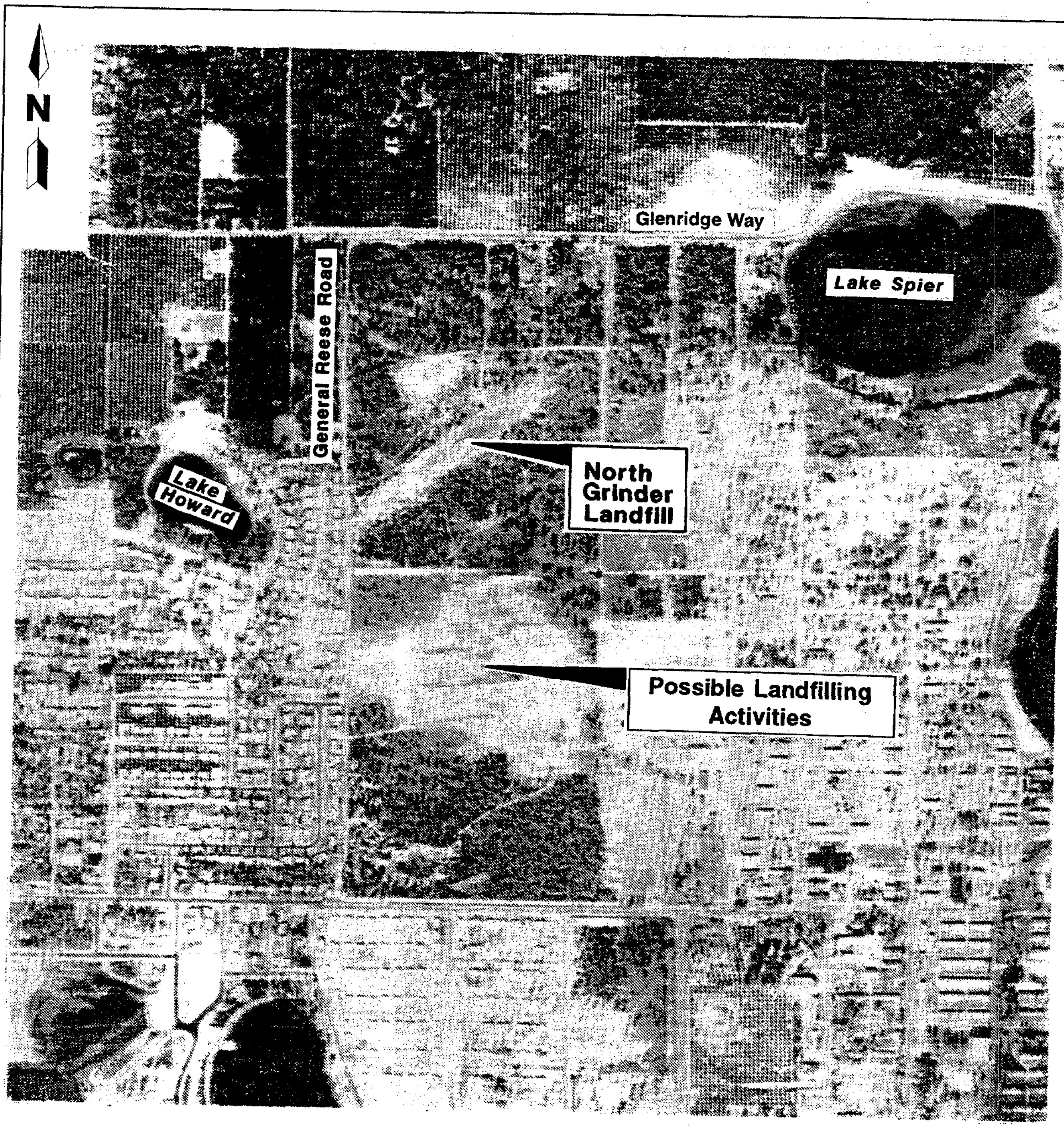
ORLANDO, FLORIDA



Source: Pre-1962-vintage Air Force photograph

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SCALE: 1 INCH = 2000 FEET

FIGURE 1-4
HISTORICAL AERIAL PHOTOGRAPH OF NORTH AND SOUTH GRINDER AREAS

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SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

REMEDIAL INVESTIGATION OPERABLE UNIT 1

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indicate that landfilling operations may have started sometime after 1939 and before 1947 (ABB-ES, 1996; 1994a). At that time, the property was wooded. The property was taken over by the U.S. Army Air Corps in 1940. Drawings from this era suggest that a camouflage demonstration area was also located in what is currently North Grinder and may have contributed to the appearance of the aerial photographs. The landfill eventually encompassed a 15-acre area and was closed in 1967 prior to the construction of two dormitories, Buildings 212 and 214. During their construction, landfill materials were discovered, excavated, and backfilled before foundation structures were established. The disposition of excavated materials is unknown (ABB-ES, 1995d). Some pockets of landfill material may still exist, as base electrical shop personnel have reported observations of photographic film during excavation in the vicinity of Buildings 212 and 214 (ABB-ES, 1995e).

Figure 1-5 (U.S. Air Force, 1964) indicates that the North Grinder parade field not only was the site of a sanitary landfill, but also accommodated a fire-fighting training area and a skeet range. The firefighting training area was located approximately 450 feet south of the present location of the training ship mockup, Building 208, the *USS Bluejacket*. According to former base firefighters, the firefighting training area was used on a weekly basis from 1961 until 1965. Gasoline, diesel fuel, or oil was used to ignite the fires (ABB-ES, 1995e).

The skeet range was located at the present locations of Buildings 212 and 234. The skeet range has been investigated separately as Study Area 43. The South Grinder parade area is located several hundred feet to the south and appears on at least one aerial photograph (Figure 1-4) as an area with sparse vegetation. Matador missile test firing cells on the east side of the South Grinder parade area may account for some vehicular activity in the area, but landfilling activity is certainly a possibility given past disposal practices at NTC, Orlando. This possibility was addressed during the geophysical investigations discussed in Chapter 2.0.

Other structures currently in the vicinity of OU 1 include Building 207 (Reviewing Stand) and Building 206 (Gym/Field House). Known utilities (electric, water, sewer) associated with all structures and lighting near OU 1 are shown on Figure 1-6.

<u>1.3 PREVIOUS INVESTIGATIONS</u>. The first phase of the IR program at NTC, Orlando was the IAS conducted in 1985 (C.C Johnson, 1985). This program included an archival search and site walkovers at all four facilities of NTC, Orlando. Nine potentially contaminated sites were identified, including OU 1 (then designated Site 1). Of the nine sites, five were recommended for further investigation in a verification study. OU 1 was included in this recommendation.

In 1986, the verification study was performed by Geraghty & Miller (Geraghty & Miller, 1986) and included the installation and sampling of four shallow monitoring wells at OU1.

The results of these previous investigations are discussed in further detail below.

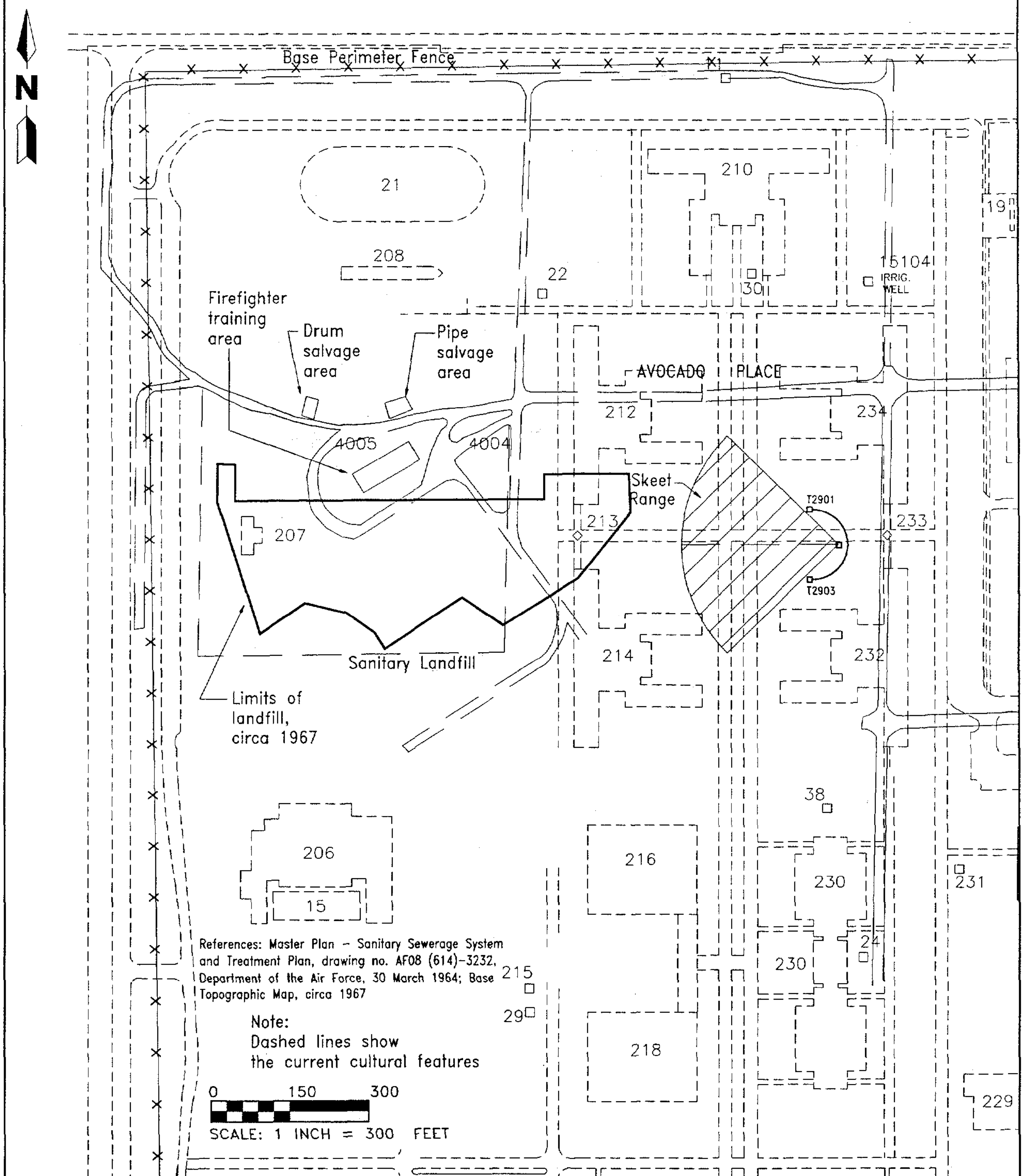

FIGURE 1-5
HISTORICAL MAP (1964 TO 1967) OF NORTH GRINDER AREA

REMEDIAL INVESTIGATION OPERABLE UNIT 1

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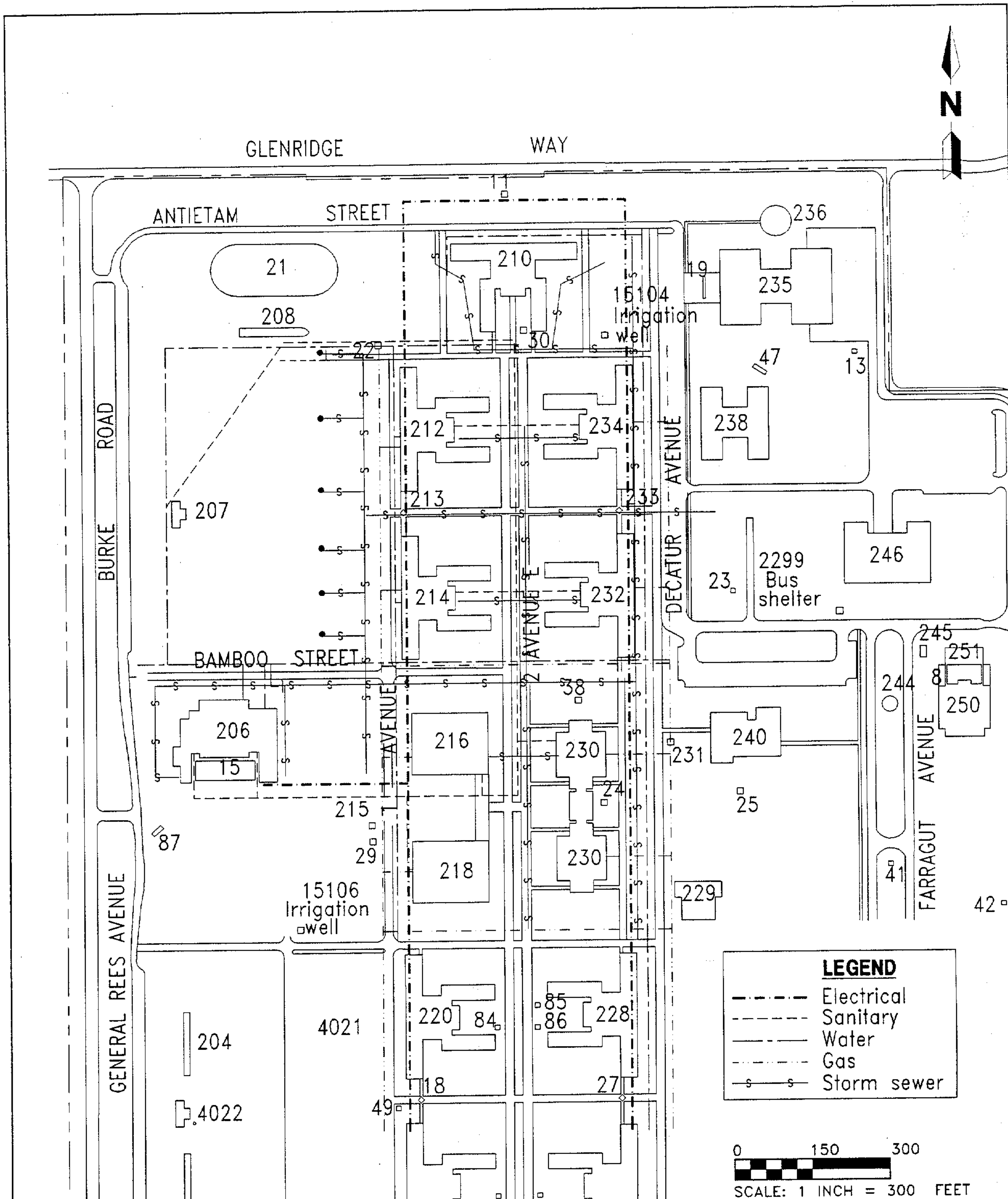

FIGURE 1-6
UTILITY LOCATION MAP

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

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SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

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1.3.1 Initial Assessment Study The IAS (C.C. Johnson and Associates, 1985) estimated that the volume of waste landfilled at OU 1 was 194,000 cubic yards. Approximately 1/3 of this volume was excavated during construction of Buildings 212 and 214 in 1967. Landfill wastes reportedly included the following:

- film;
- photographic chemicals;
- paint thinner;
- garbage from mess halls;
- cardboard boxes, paper, and plastic;
- biological wastes and syringes from the hospital;
- tree limbs and construction materials; and
- perchloroethylene (PCE) stillbottoms from laundry (stillbottoms are residues, or sludges, from drycleaning operations that require PCE as a cleaning agent).

Based on this information, the North Grinder Area (designated Site 1 in the IAS) was recommended for further investigation in a verification study.

1.3.2 Verification Study Four shallow monitoring wells (Figure 1-7) were installed around the perimeter of OU 1 during the verification study (Geraghty & Miller, 1986). Groundwater samples were collected for analysis of USEPA priority pollutants, including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides and polychlorinated biphenyls (PCBs), metals, cyanide, and total radiological activity (gross alpha and gross beta). A summary of the results is presented in Table 1-1.

These results indicate exceedances of Florida maximum contaminant levels (MCLs) for arsenic and gross alpha radionuclides. The shallow wells installed during the verification study may not have been deep enough to detect a potential plume of PCE. Based on these considerations, OU 1 was recommended for a remedial investigation.

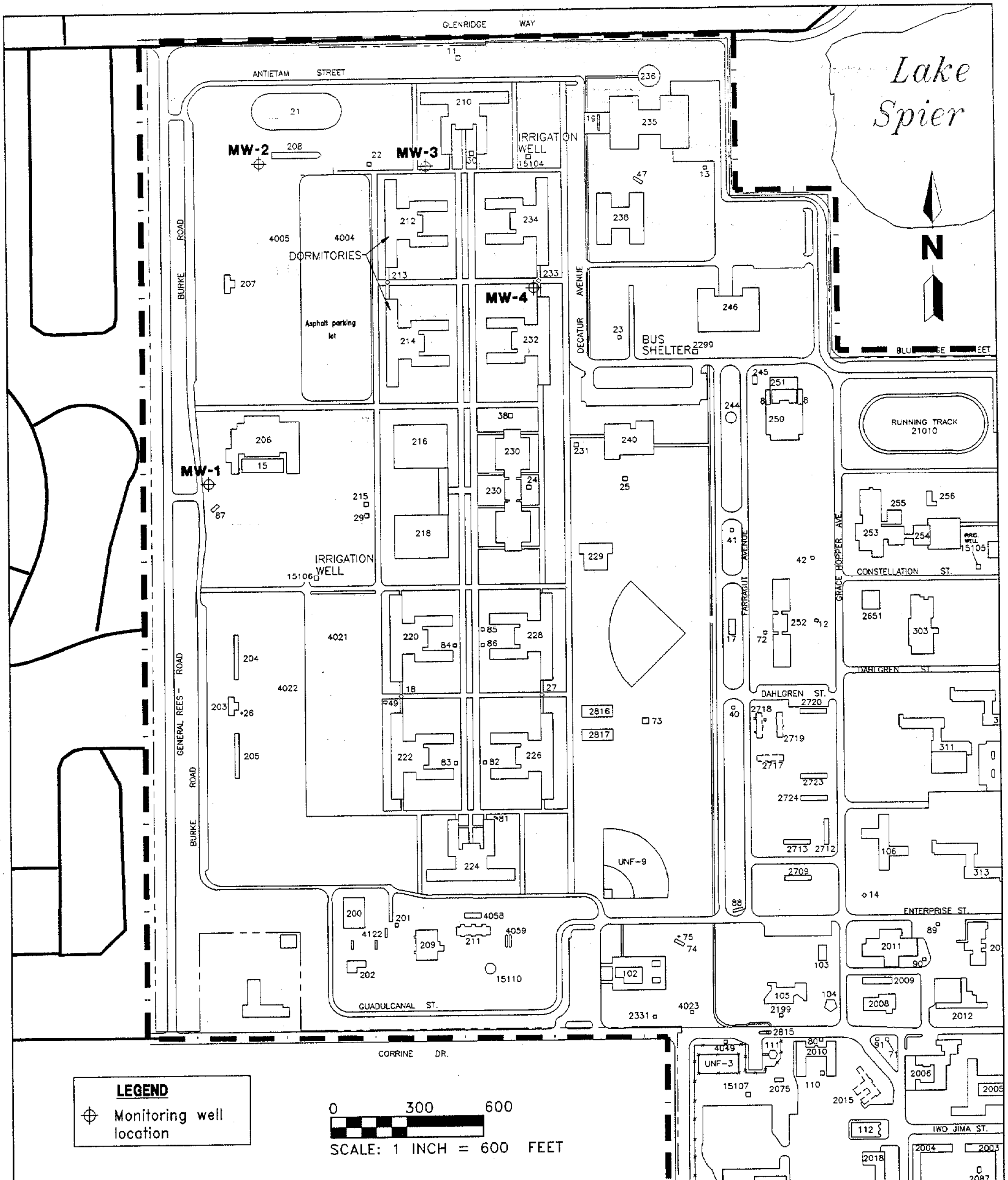

FIGURE 1-7
MONITORING WELL LOCATIONS
VERIFICATION STUDY
NORTH GRINDER AREA

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

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Table 1-1
Summary of Results of Groundwater Analyses in Verification Study

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Compound	Location	Concentration	Federal MCL	State MCL
Iron	MW-1	1.5 ppm	N/A	0.3 ppm[1]
Arsenic	MW-3	68 ppb	50 ppb	50 ppb
Gross alpha	MW-1 thru MW-4	20 to 41 pCi/ℓ	15 pCi/ℓ	15 pCi/ℓ
Gross beta	MW-1 thru MW-4	28 to 38 pCi/ℓ	50 pCi/ℓ[2]	50 pCi/ℓ[2]
Methylene chloride (dichloromethane)	MW-4	15 ppb	5 ppb	5 ppb

[1] Secondary standard.
[2] Gross beta screening level is being referenced because specific nuclides must be known in order to convert to dose (whole body or organ) before a comparison to the 4 millirem per year Federal and State MCL can be made.

Notes: MCL = maximum contaminant level.
ppm = parts per million.
N/A = not applicable.
ppb = parts per billion.
pCi/ℓ = picocuries per liter.

2.0 REMEDIAL INVESTIGATION ACTIVITIES AND RATIONALE

The following subsections provide a description of the field activities which have been completed for site characterization at OU 1. The investigation which took place was focused, consistent with the presumptive remedy of containment. The Conceptual Site Model developed during the workplan (ABB-ES, 1995d) has made reasonable assumptions regarding various contamination pathways and receptors, but has allowed for potential deviations from those initial assumptions to permit flexibility during the implementation of the field investigation. All of the activities were performed in accordance with the guidelines set forth in the POP (ABB-ES, 1994b). All well installation, development, and sampling activities were performed in accordance with Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) guidelines for groundwater monitoring well installation (ABB-ES, 1994b) and as specified in the USEPA Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (USEPA, 1991c).

2.1 LEVEL II DATA QUALITY OBJECTIVE (DQO) INVESTIGATIVE METHODS. The USEPA has identified five general levels of analytical data quality as being potentially applicable to field investigations conducted at potential hazardous waste sites under the CERCLA. DQOs specify the quality of data needed from a particular data activity to support specific decisions. The DQOs are the starting point in the design of the investigation and match sampling and analytical capabilities to specific data sets, ensuring that the quality of the data is consistent with project requirements. These levels are summarized as follows.

Briefly, Level I data are intended for field screening and are characterized by the use of portable instruments that can provide real time qualitative data to assist in the optimization of sampling point locations and for health and safety support. Level II data are intended for field analysis and are characterized by the use of portable analytical instruments that can be used onsite or in mobile laboratories stationed near a site. Depending on the types of contaminants, sample matrix, and personnel skills, qualitative and quantitative data can be obtained. Level III data are analytical data characterized by the use of methods other than the Contract Laboratory program (CLP) Routine Analytical Services (RAS), without the CLP requirements for documentation. Level IV data are analytical data obtained by CLP-RAS, which include rigorous quality assurance and quality control (QA/QC) protocols and documentation and provide qualitative and quantitative analytical results. Level V data are obtained by nonstandard methods and may include analyses that may require modification and/or development.

The investigative methods discussed below are considered DQO Levels I and II.

2.1.1 Aerial Photography Evaluation Historical aerial photographs, provided by the Navy at the Public Works Office, were evaluated during the planning phases of this RI. The objective of the evaluation was to determine the operational history of the landfill and to verify earlier historical accounts. Unfortunately, the photographic history is not well documented, particularly prior to 1962. Available photographs were of variable quality ranging from high altitude to low and from oblique to vertical. Seven aerial photographs of the area, which included OU 1, were available dating from 1954 through 1984.

The most useful photographs were from the early 1960s (the Grinder Landfill was in operation from its beginnings sometime between 1939 and 1947 up until the Air Force transferred the property to the Navy in 1968). They indicate that the landfill was probably operated as several long northeast-southwest trenches (Figure 1-4). Photographs from Herndon Annex may also be significant because they demonstrate that some of the historical landfilling practices involved excavating trenches followed by disposal, burning, and cover. While burning has not been documented for the North Grinder Landfill, it may have taken place.

Figure 1-4 shows the area, now occupied by the North and South Grinder Parade fields, during what is believed to be the height of landfilling activity (pre-1962). The bare area, now occupied by the South Grinder Parade field, prompted an evaluation of whether or not landfilling activity might have taken place there (Subsection 2.1.2, below).

<u>2.1.2 **Geophysical Surveys**</u> A geophysical survey was conducted at OU 1 between March 7 and April 6, 1995. The objectives for the survey were to:

- determine the "footprint" of the North Grinder Landfill (to include an evaluation of the South Grinder Parade Area to determine if it may be a former landfill);
- locate "hot spots" in the North Grinder Landfill that might indicate concentrations of buried conductive and/or ferrous wastes and, therefore, areas within the landfill that might warrant source removal to support the selected remedial alternative; and
- characterize, to the extent possible with remote sensing techniques, the landfill cover thickness and continuity, to evaluate potential exposure.

Geophysical techniques employed during these surveys included magnetometry, terrain conductivity, time domain metal detection, and use of ground penetrating radar (GPR) (Figure 2-1). Prior to the start of the field program, an arbitrary grid coordinate system was established. A global positioning system survey was also completed to locate key features more accurately.

The reconnaissance magnetometer survey in the South Grinder Parade Area indicated that the South Grinder Area had likely not been used for landfilling activities. This permitted a focusing of the remainder of the investigation to the North Grinder Area where geophysics was successful in determining the footprint of the landfill (Figure 2-2) and in mapping areas that may indicate concentrations of buried metallic wastes. GPR was only marginally successful in determining landfill cover thickness and continuity. However, the GPR survey was supplemented by a hand augering program conducted in conjunction with the passive soil gas program (Subsection 2.1.4).

Appendix A presents the results of the geophysical effort along with descriptions of the various techniques used.

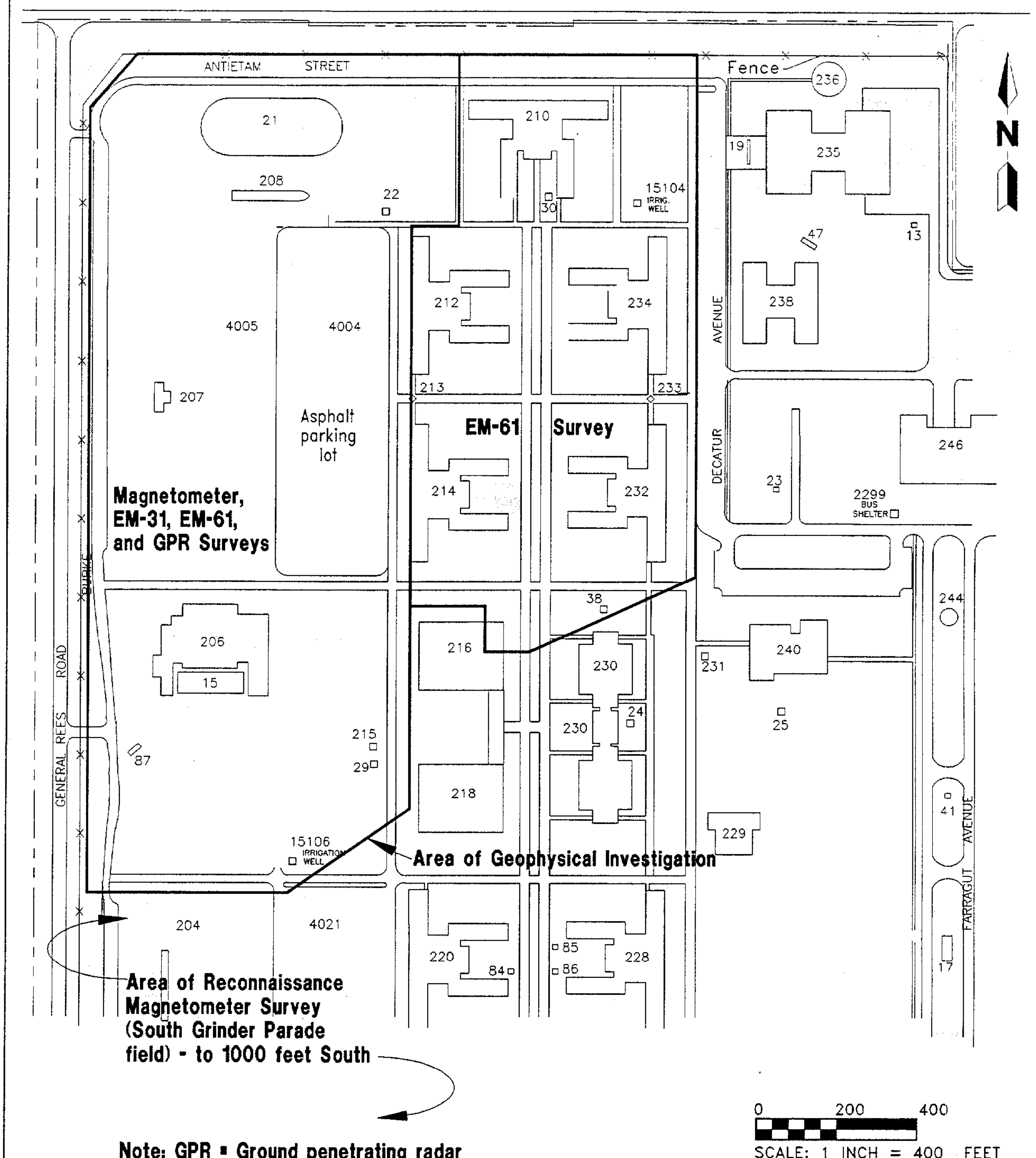

FIGURE 2-1
AREA OF GEOPHYSICAL INVESTIGATIONS

REMEDIAL INVESTIGATION OPERABLE UNIT 1

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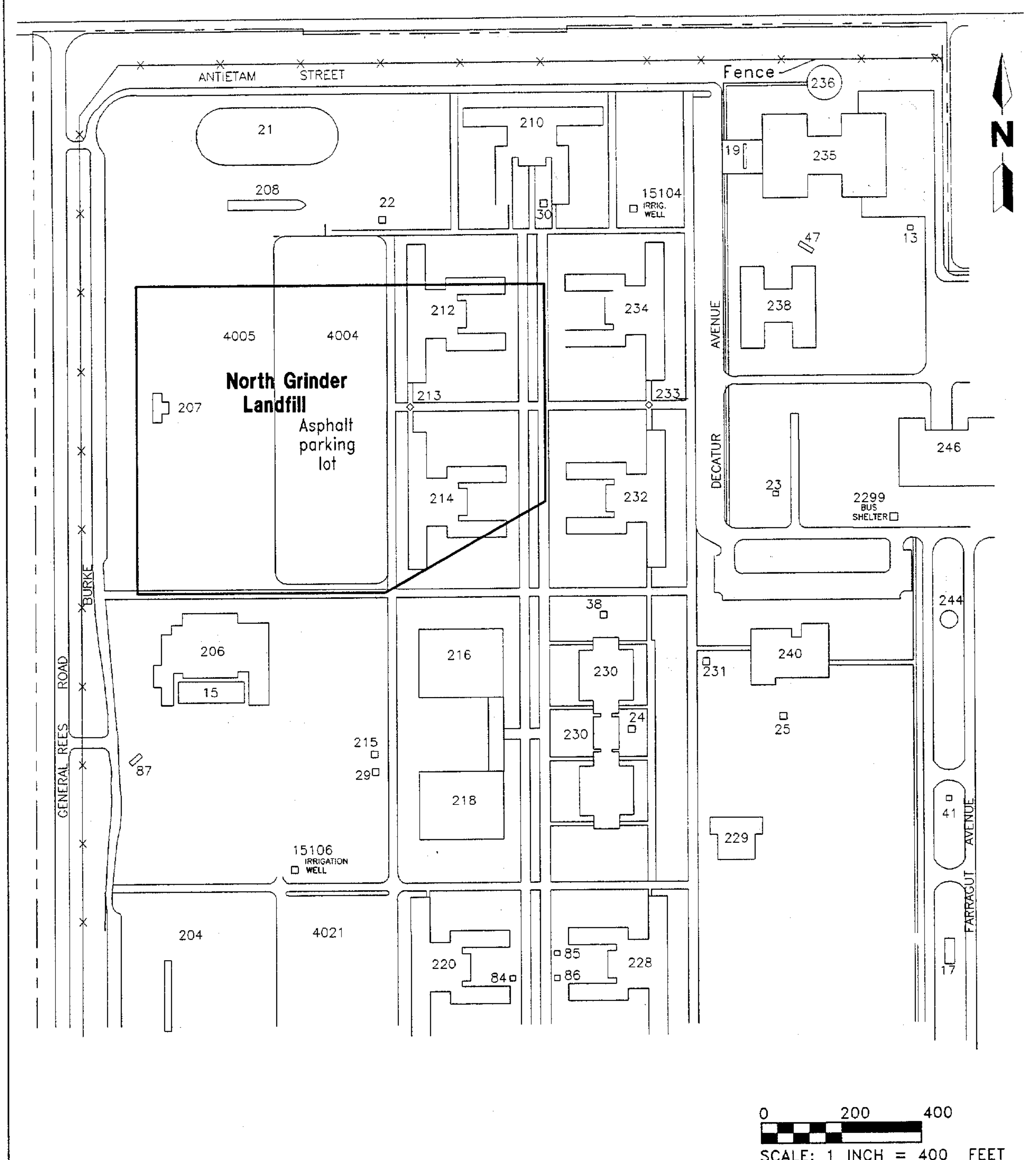

FIGURE 2-2
INTERPRETED LOCATION OF LANDFILL FROM GEOPHYSICAL DATA

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2.1.3 <u>Direct Push Technology (DPT) Surveys</u> DPT methods were employed during initial groundwater screening activities after the boundaries of the North Grinder landfill had been defined by the geophysical investigation (Figure 2-3).

The objectives for the DPT investigations were to define any contaminant plume(s) that may be present in the surficial aquifer and thus assist in optimally locating permanent well installations. The survey involved a TerraProbe^{SM} investigation followed by an electric cone penetrometer test (CPT) program. The TerraProbe^{SM} was used to collect groundwater samples from the shallow and intermediate depth ranges of the surficial aquifer, while the CPT system was used to collect groundwater samples from the deeper portions of the surficial aquifer and to obtain stratigraphic data. The TerraProbe^{SM} was also used to install permanent soil vapor implants around the perimeter of the landfill to allow monitoring of potential lateral migration of landfill gases (Figure 2-4). All groundwater and soil gas samples were analyzed on a field gas chromatograph (GC) to provide the field team with near real-time data by which they could optimize locations for subsequent explorations.

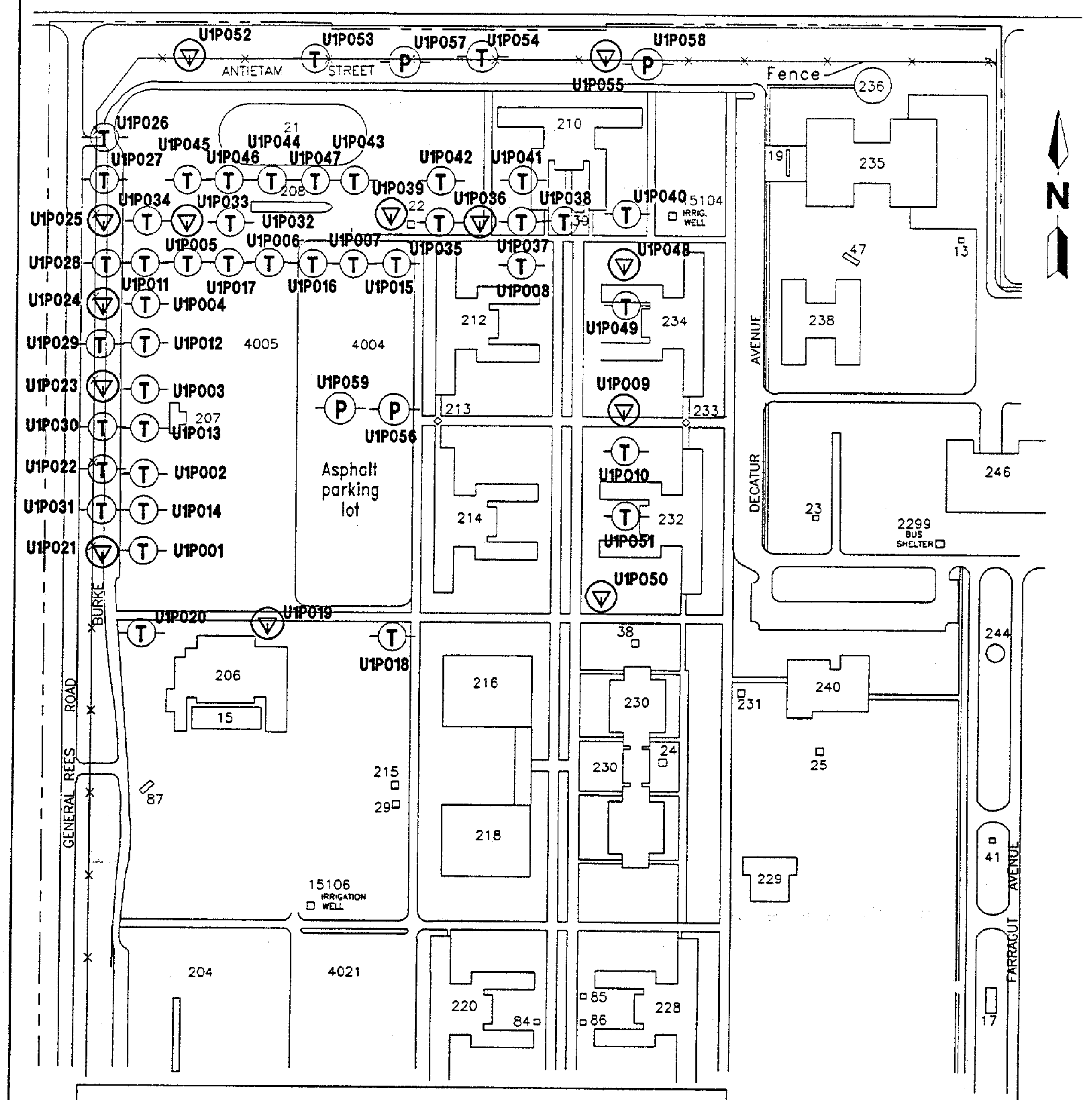
Prior to the start of the DPT activities, three temporary piezometers were installed across the central portion of the landfill (Figure 2-5) to supplement water levels from the existing three monitoring wells (one of which is no longer functional) installed during the verification study (Geraghty & Miller, 1986). Water levels taken at the three piezometers and three functional existing monitoring well locations verified that groundwater flow is northerly with a probable northeast flow component.

The TerraProbe^{SM} survey was conducted from April 12 until April 26, 1995, and the CPT investigation started on May 3 and concluded on May 23, 1995.

2.1.3.1 **TerraProbe^{SM} Surveys** The TerraProbe^{SM} rig was used to collect groundwater screening samples from 55 locations outside the perimeter of the landfill to screen for the presence of contamination in the shallow and intermediate depths of the surficial aquifer (Figure 2-3). The first 10 TerraProbe^{SM} sampling locations were spaced approximately 200 feet apart around the west, north, and east sides of the suspected landfill, as delimited by the geophysical investigation. Based on water levels in existing monitoring wells, these locations were thought to be in the downgradient and side gradient directions. Additional sampling reduced the sample spacing to 100 feet and expanded the grid to the western and northern property lines, with additional sampling to the east and south of the suspected landfill boundaries.

Sample depths at each location were controlled by the depth to the water table and the depth at which probe refusal occurred. The water level at each location was measured with a steel tape advanced down the probe rods. The majority of the water table samples were collected from the 14- to 19- foot interval. A second depth was sampled at 46 of the 55 sampling locations. The second sampling depth was usually the refusal depth for that location. At nine of the locations, the refusal depth was too close to the water table sample depth to warrant an additional sample at that location. A third sample was collected at one location at a depth of 43 to 45 feet.

All of the shallow samples and most of the intermediate depth samples were collected using a 0.020-inch slotted screen. The slotted screen is basically a



LEGEND

(T) U1P003	TerraProbe[SM] location
(▽) U1P023	Cone Penetrometer and TerraProbe[SM] location
(P) U1P056	Cone Penetrometer location

0 200 400
SCALE: 1 INCH = 400 FEET

FIGURE 2-3
DIRECT PUSH TECHNOLOGY EXPLORATIONS TERRAPROBE[SM] AND CONE PENETROMETER LOCATIONS

REMEDIAL INVESTIGATION OPERABLE UNIT 1

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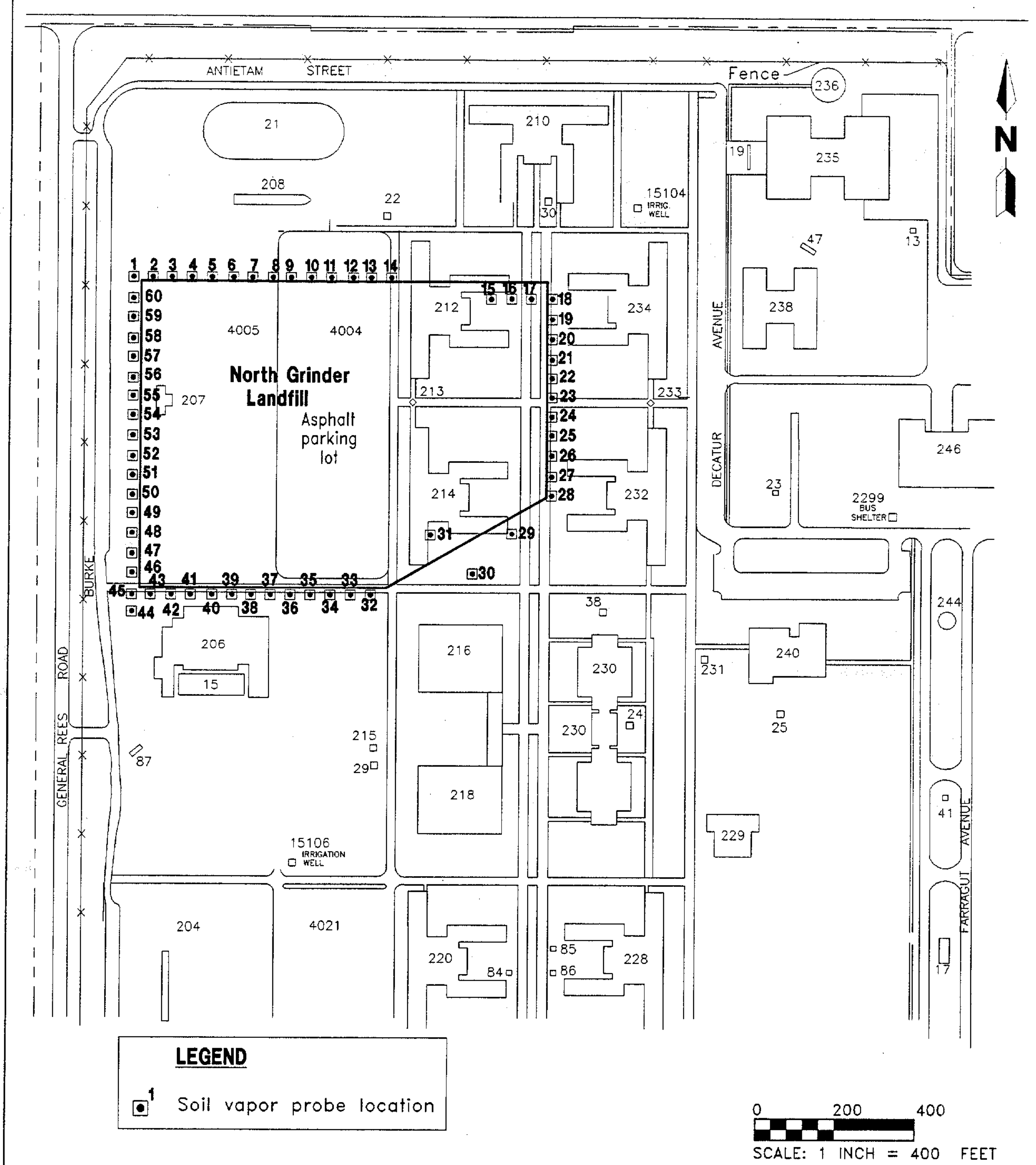

FIGURE 2-4
SOIL VAPOR PROBE LOCATIONS

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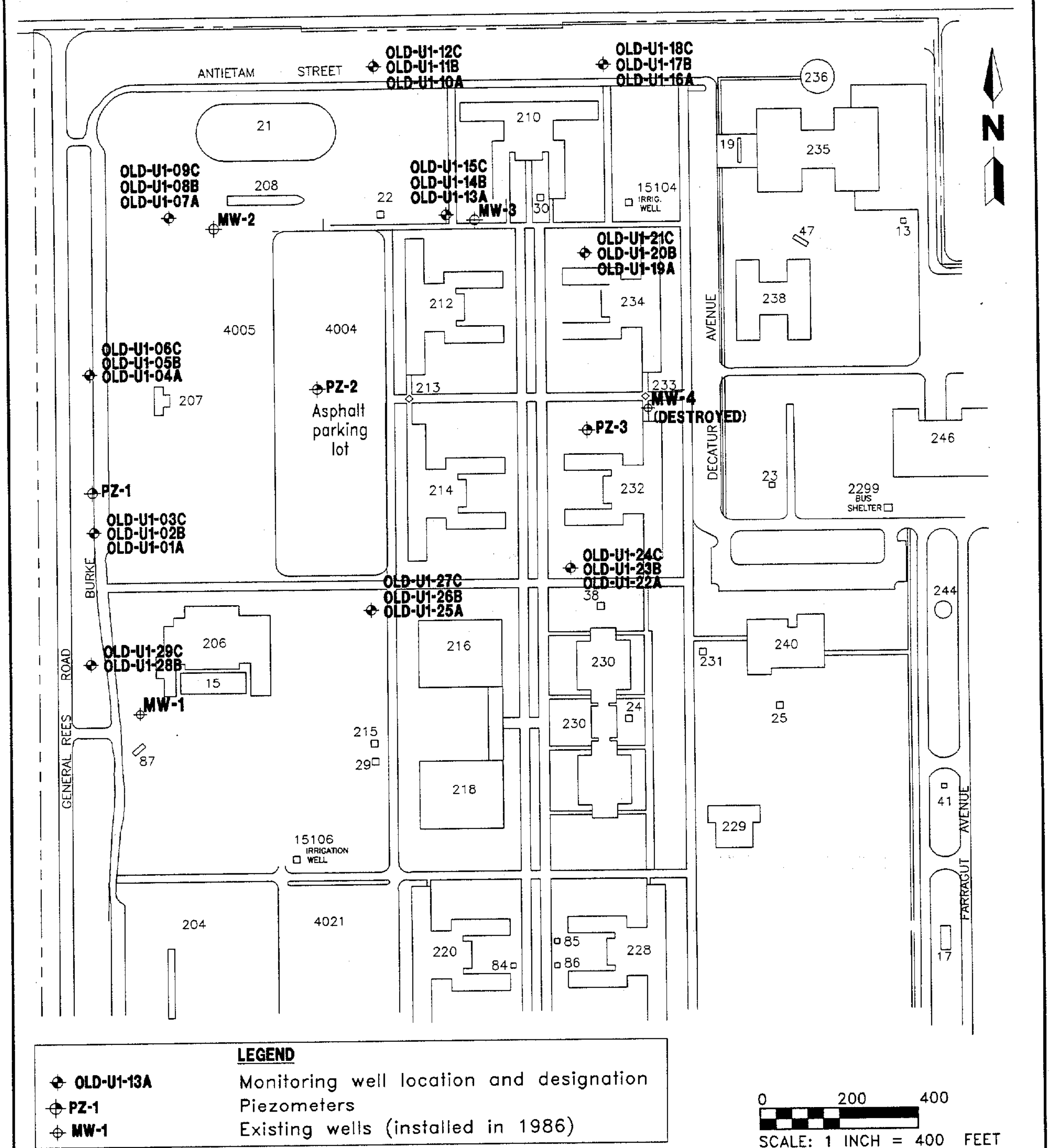

FIGURE 2-5
MONITORING WELL AND PIEZOMETER LOCATIONS

REMEDIAL INVESTIGATION OPERABLE UNIT 1

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length of rod with slots cut into the sides to allow groundwater to enter. For the last 12 of the intermediate depth samples, a retractable tip sampling tool was used instead of the slotted screen. Although the retractable tip sampling tool had no screen, it was sealed as it was advanced to the sampling depth to prevent fine sand and silt from entering the rods. The sampling tool was advanced to refusal depth, then the rods were pulled back approximately 6 inches to open the sampling tool tip. In either case, groundwater samples were collected by inserting 1/4-inch, Teflon™ tubing down the probe rods after the sampling depth had been reached. After connecting the tubing to a peristaltic pump, the sampling crew attempted to purge enough water from the probe rods to remove silt and fine sand from the tubing. The sampling crew then pulled the tubing from the probe rods, reversed the flow direction of the peristaltic pump, and collected the groundwater sample in one or more 40-milliliter (mℓ) volatile organic aromatic (VOA) vials.

The groundwater samples were analyzed on a field GC, which provided concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX), trichloroethene (TCE), and PCE. Ten samples were submitted to an offsite laboratory for volatile organics analysis using CLP methodology.

The results of the TerraProbe℠ groundwater screening effort revealed that very low levels of contaminants were present along the northwest and northern portions of the landfill, and those zones where contaminants were detected formed the basis for monitoring well location selection. Additional details on the groundwater screening results from the DPT surveys are included in Appendix B.

2.1.3.2 **CPT Surveys** Upon completion of the TerraProbe℠ groundwater sampling event, fifteen locations were chosen for further investigation by CPT soundings and deep groundwater sampling (Figure 2-3). The CPT soundings were used to provide the stratigraphic data for the surficial aquifer at the site, and the groundwater screening results were used to provide general plume delineation. The collected data were used to develop an installation and construction plan for the network of monitoring wells.

Twelve of the locations were at points previously investigated with the TerraProbe℠, and three of the locations had not been investigated. Two of the new locations were along the northern edge of the site where the CPT rig could not reoccupy the TerraProbe℠ locations. The third new location was inside the landfill boundary where hand-auger borings had reached native material without encountering landfill debris.

CPT Soundings. The CPT sounding provides a continuous log of soil lithologic properties for the entire length of the boring. The cone penetrometer measures tip resistance and sleeve friction as the cone is advanced through the soil. The soil classification is based on the values of these properties and the ratio of sleeve friction to tip stress. The cone penetrometer also measures *in situ* hydraulic pore pressure as the cone is advanced through the soil. The soil permeability controls the rate at which the pore pressure dissipates. The time versus pore pressure plot can be used to calculate permeability of formation materials. This technique works best in low permeability materials, since the pore pressure does not dissipate as rapidly. When less permeable horizons were identified during the CPT soundings, this method was used to determine if these stratigraphic units acted as effective aquitards. The results of the CPT survey, which include stratigraphic logs resulting from the 15 cone tests (2 cone tests encountered refusal at a shallow depth), are presented as Appendix C.

Groundwater Screening. Thirty-two groundwater samples were collected at 13 CPT sounding locations. Depending on lithology, two or three depths were sampled per location. Samples were collected near the water table, above any intermediate stratigraphic units that might have inhibited vertical migration of contaminants, and above the clay unit interpreted as the top of the Hawthorn Group. The groundwater sampler consisted of a sample chamber, a retractable screen and point, and a check ball assembly. Teflon® tubing strung through the cone rods connected the sampler to a nitrogen bottle in the CPT rig. The sampler was pushed to the desired depth, pressurized with nitrogen gas, and then pulled up approximately 6 inches to expose the retractable screen. Releasing the nitrogen pressure allowed the sample chamber to fill at a controlled rate. After the sampler had filled, nitrogen pressure was again applied, to seal the check ball assembly, and the sampler was retrieved to the surface.

All of the groundwater samples collected during the DPT survey were analyzed onsite on a portable GC by ABB-ES personnel. Each sample was analyzed for the concentration of any petroleum-related volatile organic compounds as well as selected volatile chlorinated solvents.

<u>2.1.4 **Passive Soil Gas Survey**</u> A passive soil gas survey was completed at OU 1 for the purpose of:

- characterizing chemicals of potential concern (CPCs) present in the soil cover in order to design a proper soil gas collection system (if needed) and allow for proper cap design;
- characterizing volatile and semivolatile constituents that have migrated to the landfill soil cover to locate potential "hot spots," which may need to be evaluated with regard to source removals to support remedial alternatives; and
- evaluating the presence of methane, which may still be problematic despite the age of the landfill.

The soil gas collectors consisted of a glass sampling vial coated with an adsorbent fused to the inside bottom of the vial. The collectors were deployed at a depth of 2 to 3 feet below land surface (bls) at their respective sampling locations in 2-inch-diameter excavated holes over a duration of 3 to 5 days. They were then retrieved and submitted for analysis, which can detect a wide range of chemical contaminants.

A total of 303 passive soil gas collectors and 14 QA/QC duplicates were installed (Figure 2-6) between April 21 and 23, 1995, on 50-foot centers over the landfill area, except in cases where obstructions were encountered (i.e., buildings, impenetrable soil, buried utilities). The collectors were placed inside a length of polyvinyl chloride (PVC) pipe that was capped at the bottom end where holes were drilled to allow gases from the vadose zone to enter. The pipe and collector assembly were lowered into an augered 2-inch-diameter hole and placed at a depth 2 to 3 feet bls. The end of pipe near the surface was covered with

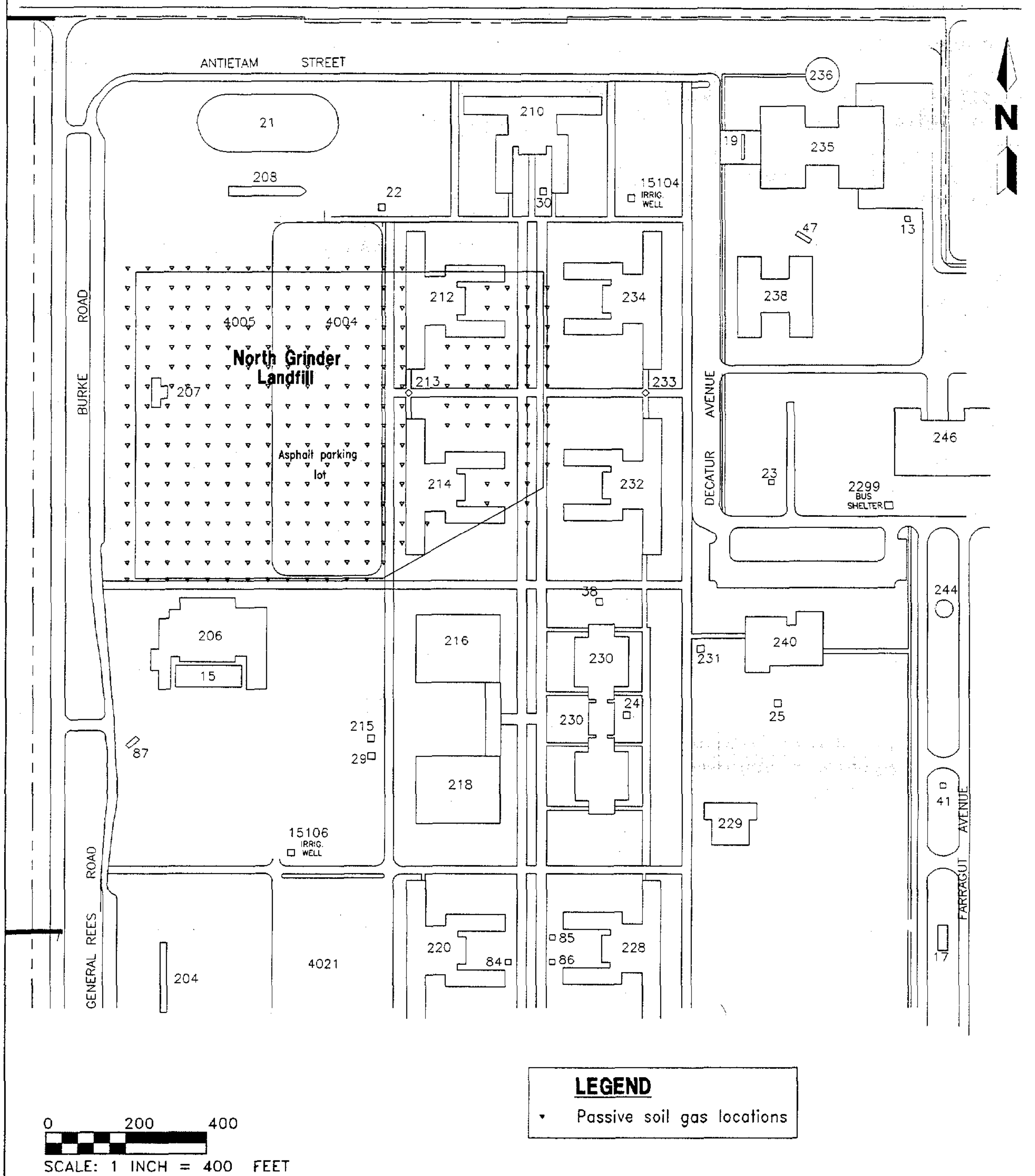


FIGURE 2-6
PASSIVE SOIL GAS LOCATIONS
OPERABLE UNIT 1,
NORTH GRINDER LANDFILL

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

H:\ORLANDO\FINALRI\PASGAS\CCK-NAB\04-09-96 aluminum foil, and the hole was backfilled with soil. The times of sample emplacement and sample locations were recorded.

Augering was conducted in soil with a 2-inch-diameter hand auger. If the location was on asphalt, an electric hammer drill was used to penetrate the surface. After augering, the hole was monitored briefly with a portable flame ionization detector (FID) for health and safety purposes, and readings were recorded.

Soil gas collectors were retrieved between April 24 and 26, 1995, after being in place a minimum of 72 hours. Each hole was backfilled with the excavated material and cold-patched with asphalt, if necessary. Samples were placed in plastic bags and submitted for analysis. Personnel responsible for placing and retrieving the samples wore latex gloves.

Hand augers and drill bits were decontaminated between locations to comply with USEPA Region IV DQOs in accordance with procedures detailed in the POP (ABB-ES, 1994b).

Samples were analyzed according to modified USEPA Methods 8010 and 8020. Modified USEPA Method 8010 analysis was conducted with a GC equipped with an electron capture detector (ECD) using direct injection, and the analytes standardized for analysis were the following:

- 1,1-dichloroethene (1,1-DCE)
- methylene chloride (CH2CL2)
- trans-1,2-dichloroethene (t12DCE)
- 1,1-dichloroethane (1,1-DCA)
- cis-1,2-dichloroethene (c12DCE)
- chloroform (CHCL3)
- 1,1,1-trichloroethane (1,1,1-TCA)
- carbon tetrachloride (CCL4)
- trichloroethene (TCE)
- 1,1,2-trichloroethane (1,1,2-TCA)
- perchloroethylene (PCE)

Modified USEPA Method 8020 analysis was conducted with a GC equipped with an FID using direct injection. The analytes standardized for analysis were the following:

- benzene
- toluene
- ethylbenzene
- meta- and para-xylene
- ortho-xylene

A hand augering program was completed in conjunction with the installation of 303 passive soil gas collectors to depths ranging from 22 to 36 inches bls. It was determined that the soil cover over the North Grinder Landfill is a buff to brown fine to medium sand with little fines. The soil cover is a minimum of 22 inches thick except in two locations where refuse was encountered at a depth of 18 inches bls.

The results of the passive soil gas survey along with a summary of the hand augering program completed during passive soil gas collector installation are presented in Appendix D-1.

<u>2.1.5 Active Soil Gas Survey</u> An active soil gas survey was conducted at OU 1, which consisted of installing and sampling soil vapor implants around the perimeter of the landfill. The objective was to evaluate the presence and potential lateral migration of methane generated by landfilled materials. Landfill gas collection and treatment is an important consideration of source containment under the presumptive remedy.

Following the DPT groundwater screening, 60 active soil gas sampling implants were installed on April 26, 27, 28 and May 1, 1995, around the perimeter of the landfill (Figure 2-4). The implants were spaced at approximately 50-foot intervals, except in the northeast and southeast corners, where buildings prevented implant placement.

2.1.5.1 **Soil Vapor Implant Installation** The following method was used to install the active soil gas sampling implants. An 8-inch-diameter hole was hand-augered to a depth of 1 foot at each implant location. The TerraProbe^{SM} rods were then driven to a depth of 5 feet in the center of the hand auger hole. The lead TerraProbe^{SM} rod was equipped with a special adaptor and a sacrificial conical point. An 8-inch stainless-steel screen was connected to 3/8-inch-diameter polyethylene tubing and inserted down the rods. After the tubing was cut off flush to the top of the rods, the rods were slowly withdrawn. After the rods had been withdrawn, the depth of the hole was measured with a wooden dowel. Clean silica sand was poured down the hole to cover the screen unless the hole had caved as the rods were withdrawn, in which case no additional material was added. The remainder of the hole was backfilled with bentonite flakes to a depth of 1.5 feet bls. The bentonite was hydrated as it was added, sealing the hole from surface infiltration. A protective PVC casing with a threaded cap was then cemented in place to protect the implant.

2.1.5.2 **Soil Vapor Implant Sampling** The soil vapor implants (Figure 2-4) were sampled on June 22, 23 and 26, 1995. Three of the original 60 implants were filled with water at the time of sampling, so only 57 samples were collected.

The polyethylene tube at the top of the soil vapor implant was connected to the TerraProbe^{SM} vacuum tank system via silicon tubing secured with hose clamps. A vacuum was created within the tank, and upon opening of a valve, a predetermined volume of atmosphere was drawn up from the ground to purge stagnant soil gas within the implant. Giving the system time to equilibrate, the sample was taken by piercing the silicon tubing with a 250-microliter ($\mu\ell$) syringe and withdrawing 200 $\mu\ell$ of gas. The syringe tip was capped and transported to the field lab and injected into an HNu, Inc. (HNu) 311 GC with a photoionization detector. Standard analytes were benzene, toluene, ethylbenzene, meta-xylene, para-xylene, ortho-xylene, TCE, PCE, and DCA. Eleven duplicate samples were also taken for quality control. Sixteen samples had analytes that were detected on the field GC, but all of the detections were at very low concentrations. Methane screening was performed in each of the soil vapor implant locations, and there were no methane detections. The results of the GC analyses and methane screening are presented in Appendix D-2.

2.1.6 Soil Borings The objective for installing soil borings was to verify the lithologic data obtained by DPT methods and to characterize the site geologically. Based on DPT results (55 TerraProbe[SM] sampling points with 117 groundwater screening samples, and 15 CPT soundings with 35 groundwater samples from 13 locations), nine monitoring well cluster locations were selected (with approval from the OPT) that would best characterize the local geology and hydrology at OU 1 (Figure 2-5). Each cluster was composed of three monitoring wells screened at the water table, at an intermediate depth within the surficial aquifer, and at the top of the Hawthorn Group at the base of the surficial aquifer.

The deep well at each cluster location was sampled continuously to the uppermost clay lens and/or layer within the Hawthorn Group providing lithologic data that would be correlated with the DPT results to construct the stratigraphic framework beneath the study area. Soil samples were collected in accordance with Subsection 4.5.1 of the POP (ABB-ES, 1994b).

Soil boring logs are presented in Appendix E.

2.1.7 Monitoring Well Installation Nine monitoring well clusters, consisting of three permanent wells (27 total), were initially installed to characterize the groundwater quality and hydraulic characteristics of the surficial aquifer (Figure 2-5). Monitoring well clusters were installed because of the differing migration properties of potential contaminants present. Cluster locations were based (with approval from the OPT) on previous CPT results, groundwater flow direction, and complete coverage around the landfill. In accordance with the workplan (ABB-ES, 1995d), each cluster was composed of three monitoring wells, one screened at the water table (12.5 to 22.5 feet bls), one at an intermediate depth within the surficial aquifer (27.5 to 49.5 feet bls), and one at the top of the Hawthorn Group at the base of the surficial aquifer (47.5 to 69.5 feet bls).

Shallow wells were constructed to bracket the water table and thus capture light nonaqueous-phase liquid (LNAPL). The placement of the intermediate wells was controlled by lithology and was intended to screen the interval above potential vertical migration barriers, which would act as contaminant accumulation points within the surficial aquifer. If appropriate lithologies were not encountered, then intermediate wells were screened approximately halfway between the water table and the base of the surficial aquifer. Deep wells were screened above the uppermost clay layer within the Hawthorn Group.

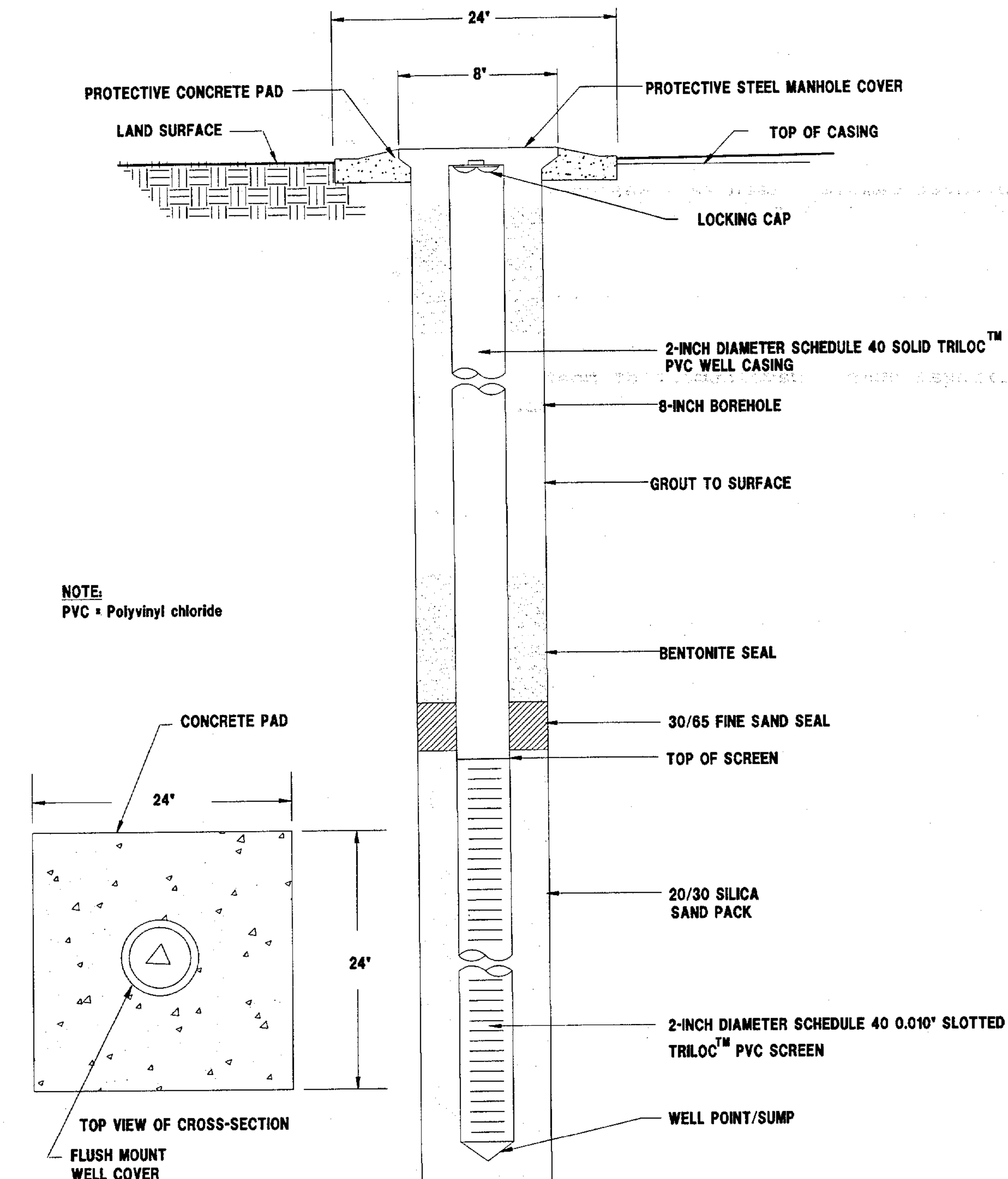
A second phase of monitoring well installation was conducted after groundwater analyses of samples collected from the initial upgradient wells revealed elevated radioisotopes in the basal zone of the aquifer. Without background radiological data for this depth anywhere at NTC, Orlando, both the USEPA and the FDEP recommended installing an additional monitoring well cluster, screened within this interval of the aquifer, farther upgradient from the landfill. Two new monitoring wells (intermediate and deep) were installed along the Main Base's western property line. The location selected was the farthest possible distance upgradient from the landfill on Navy property.

The monitoring wells were installed with a 10-inch-diameter, hollow-stem auger. All of the monitoring wells were constructed of 2-inch inside-diameter, Schedule 40, threaded, flush-jointed, PVC screen and riser. The shallow wells have 10 feet of 0.010-inch slotted screens. The intermediate and deep wells were constructed with 5 feet of screen. The annular space around the well screens was backfilled with a clean silica sand, compatible with the screen slot size, extending from a maximum of 2 feet below the bottom of the well screen to 3 feet above the top of the screen. A 2-foot fine sand seal was placed above the filter pack. A minimum 2-foot-thick bentonite pellet seal was installed above the sand pack. A cement-bentonite grout was tremied from the top of the bentonite seal to within 2 feet of the ground surface. After a minimum of 24 hours set time for the grout, the wells were developed to remove fine soil particles, improve the hydraulic connection with the natural formation, and obtain a representative groundwater sample. Each well was completed with a flush mount, 8-inch-diameter vault encased in a 2-foot by 2-foot concrete pad with a locking cap for security. Typical monitoring well construction diagrams are provided on Figure 2-7. Table 2-1 summarizes the construction details for each well. Monitoring well construction diagrams are provided in Appendix F-1.

ABB-ES personnel developed each monitoring well by pumping water through a centrifugal pump. Development of most of the deep wells was initiated with an inertial pump and completed with a centrifugal pump. No air or water was injected into the wells during development. At least three well volumes were purged from each well, until the water was clear and free of turbidity, and/or until field measurements of pH, temperature, and conductivity stabilized. All of the parameters were measured regularly during the development process and logged into the field logbook. Copies of the monitoring well development logs are provided in Appendix F-2.

__2.1.8 Aquifer Characterization__ *In situ* hydraulic conductivity tests were performed on the 27 monitoring wells installed during this investigation. Rising-head slug tests were run for all the wells; falling-head tests were run only on wells where the water table was above the screened interval of the monitoring well. Before each test, the monitoring wells were opened and allowed to equilibrate with ambient air conditions. A static water-level measurement was recorded after the well had equilibrated. A 30-pounds-per-square-inch (psi) transducer was lowered into the monitoring well far enough below the water surface to prevent interference with the slug. In shallow wells, the transducer was lowered to within 2 feet of the bottom of the well so that accumulated silts in the bottom of the well would not interfere with the ports. Time was allowed for the transducer to equilibrate with the new conditions and for the water level to return to a static level. When feasible, the transducer cable was taped to the well pad to prevent vertical movement of the transducer. The transducer was connected to a Hermit 1000c data logger. After equilibrium was reached, the slug was submerged and the data logger started. The slug test was allowed to run a minimum of 10 minutes so that the step function of the data logger could be used. When the water level had recovered to at least 90 percent of static levels, the test was stopped. The slug was removed swiftly from the well and the rising head part of the test was begun. The well was again allowed to recover to 90 percent of static water level before the test was stopped.

The data were downloaded to a computer and processed using the method of Bouwer and Rice (1976) as implemented in the Aqtesolv® software program. For wells where the top of the screen was above the water table, the plot was analyzed using the double straight line method (Bouwer, 1989) to account for filter pack



Note: All shallow monitoring wells constructed with 10 feet of screen. All intermediate and deep monitoring well constructed with 5 feet of screen.

FIGURE 2-7
TYPICAL MONITORING WELL CONSTRUCTION DETAIL

REMEDIAL INVESTIGATION OPERABLE UNIT 1

NAVAL TRAINING CENTER ORLANDO, FLORIDA

Table 2-1
Monitoring Well Construction Details

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Well ID	Date Installed	Well Depth (feet bls)	Screen Interval	Filter Pack Interval	Seal Interval	Grout Interval
OLD-U1-01A	6/19/95	13	2.5-12.5	1.5-13	1-1.5	0-1
OLD-U1-02B	6/19/95	28	22.5-27.5	20.5-28	18.5-20.5	0-20.5
OLD-U1-03C	6/19/95	58	52.5-57.5	50.5-58	48.5-50.5	0-50.5
OLD-U1-04A	6/21/95	21	10.5-20.5	8.5-21	6.5-8.5	0-6.5
OLD-U1-05B	6/21/95	37	31.5-36.5	29.5-37	27.5-29.5	0-27.5
OLD-U1-06C	6/20/95	58	52.5-57.5	50.5-58	48.5-50.5	0-48.5
OLD-U1-07A	6/22/95	22	11.5-21.5	10.5-13	8-10.5	0-8
OLD-U1-08B	6/22/95	41	35.5-40.5	33.5-41	31.5-33.5	0-31.5
OLD-U1-09C	6/22/95	57	51.5-56.5	49.5-57	47.5-49.5	0-47.5
OLD-U1-10A	7/7/95	23	12.5-22.5	11-23	8-11	0-8
OLD-U1-11B	7/7/95	40	34.5-39.5	33-40	31-33	0-31
OLD-U1-12C	7/6/95	65	59.5-64.5	58-65	56-58	0-56
OLD-U1-13A	6/26/95	23	12.5-22.5	11-23	9-11	0-9
OLD-U1-14B	6/26/95	40	34.5-39.5	33-40	31-33	0-31
OLD-U1-15C	6/26/95	54.5	49-54	47-54.5	45-47	0-45
OLD-U1-16A	7/5/95	20	9.5-19.5	8-19.5	6-8	0-6
OLD-U1-17B	7/5/95	35	24.5-34.5	28-35	26-28	0-26
OLD-U1-18C	6/30/95	48	37.5-47.5	41-48	39-41	0-39
OLD-U1-19A	6/29/95	23	12.5-22.5	16-23	14-16	0-14
OLD-U1-20B	6/29/95	35	29.5-34.5	28-35	26-28	0-26
OLD-U1-21C	6/30/95	41	45.5-50.5	44-51	42-44	0-42
OLD-U1-22A	6/15/95	20	9.5-19.5	8-20	6-8	0-6
OLD-U1-23B	6/15/95	40	35.5-39.5	33.5-40	31.4-33.5	0-33.5
OLD-U1-24C	6/16/95	70	64.5-69.5	62.5-70	60.5-62.5	0-60.5
OLD-U1-25A	6/13/95	20	9.5-19.5	8-20	6-8	0-6
OLD-U1-26B	6/13/95	50	44.5-49.5	42.5-50	40.5-42.5	0-40.5
OLD-U1-27C	6/12/95	63	57.5-62.5	56.5-63	54.5-56.5	0-54.5
OLD-U1-28B	7/31/96	33	27.5-32.5	26-33	23-26	0-23
OLD-U1-29C	8/1-96	65	59.5-64.5	58-65	55-58	0-55

All wells constructed with 2-inch Schedule 40 polyvinyl chloride casing and screen. All well screens are equipped with 0.01-inch slots. All soil borings were advanced with 6-1/4-inch inside diameter augers (10-inch nominal outside diameter).

Notes: ID = identification.
bls = below land surface.

Source:ABB Environmental Services, Inc., 1995.

drainage. Dissipation tests conducted during the CPT investigation provided conductivity values for the less permeable horizons at the site (Appendix C).

<u>2.1.9 Sample Point Elevation Survey</u> Prior to the initiation of fieldwork, a reference grid with arbitrary northing and easting coordinates was established over the study area. During subsequent field investigations, this coordinate system was used to identify sampling locations. The northing and easting (North American Datum [NAD] 83 State Plane Florida East Zone grid coordinate system) of each of these points was surveyed by ABB-ES personnel using a Global Positioning System (GPS) satellite receiver connected to a real-time differential correction receiver (Appendix A). The survey inventory included 12 points on the reference grid to tie in sample locations that used the coordinate system with other coordinate systems. Eighteen monitoring wells, as well as three previously installed monitoring wells and three temporary piezometers, were surveyed. Mapped cultural features were included in the inventory to allow alignment of the site reference grid with known features. These features included the corners of Buildings 206 and 208 and the roads and paved areas of the North Grinder parade ground.

Each of the 29 permanent monitoring well locations was later surveyed by registered professional surveyors. The surveyors established the elevation (referenced to mean sea level) and northing and easting coordinates (NAD 83, Florida East Zone) of the top of the casing of each well.

2.2 LEVEL IV DQO INVESTIGATIVE METHODS.

<u>2.2.1 Surface Soil Sampling</u> Surface soil sampling was completed to evaluate the quality of the existing soil cover, which was assumed to have come from a clean source, and to evaluate the adequacy of existing soil cover as a cap to prevent exposure to landfilled materials. Evaluation of surface soils will guide selection of appropriate institutional controls. The surface soil sampling program took place in a single sampling event at the frequency of one sample per acre within the landfill "footprint" defined by the aerial photography evaluation (Subsection 2.1.1) and geophysical surveys (Subsections 2.1.2 and 2.1.3). A total of 14 surface soil samples was taken (Figure 2-8). Each of the 14 samples was composited in accordance with the pattern denoted on Figure 2-9. All samples were analyzed for CLP target analyte list (TAL) metals and target compound list (TCL) organics. Samples submitted for VOCs analysis were not composited but were taken from the central node of the composite pattern.

For details on the surface soil sampling methodology, refer to Paragraph 4.5.1.1 of the POP (ABB-ES, 1994b).

<u>2.2.2 Groundwater Sampling</u> Groundwater samples were collected from each of the 29 monitoring wells installed during the investigation. Because of concerns about turbidity in the wells and the effects on metals analyses, the low-flow purge and sample method was used. The low-flow method minimizes turbulent flow and mixing of water in the well; therefore, artificial turbidity is not generated during the purging and sampling process. The result is a more rapid stabilization of turbidity and other parameters (pH, temperature, specific conductivity) and a sample more representative of conditions in the formation.

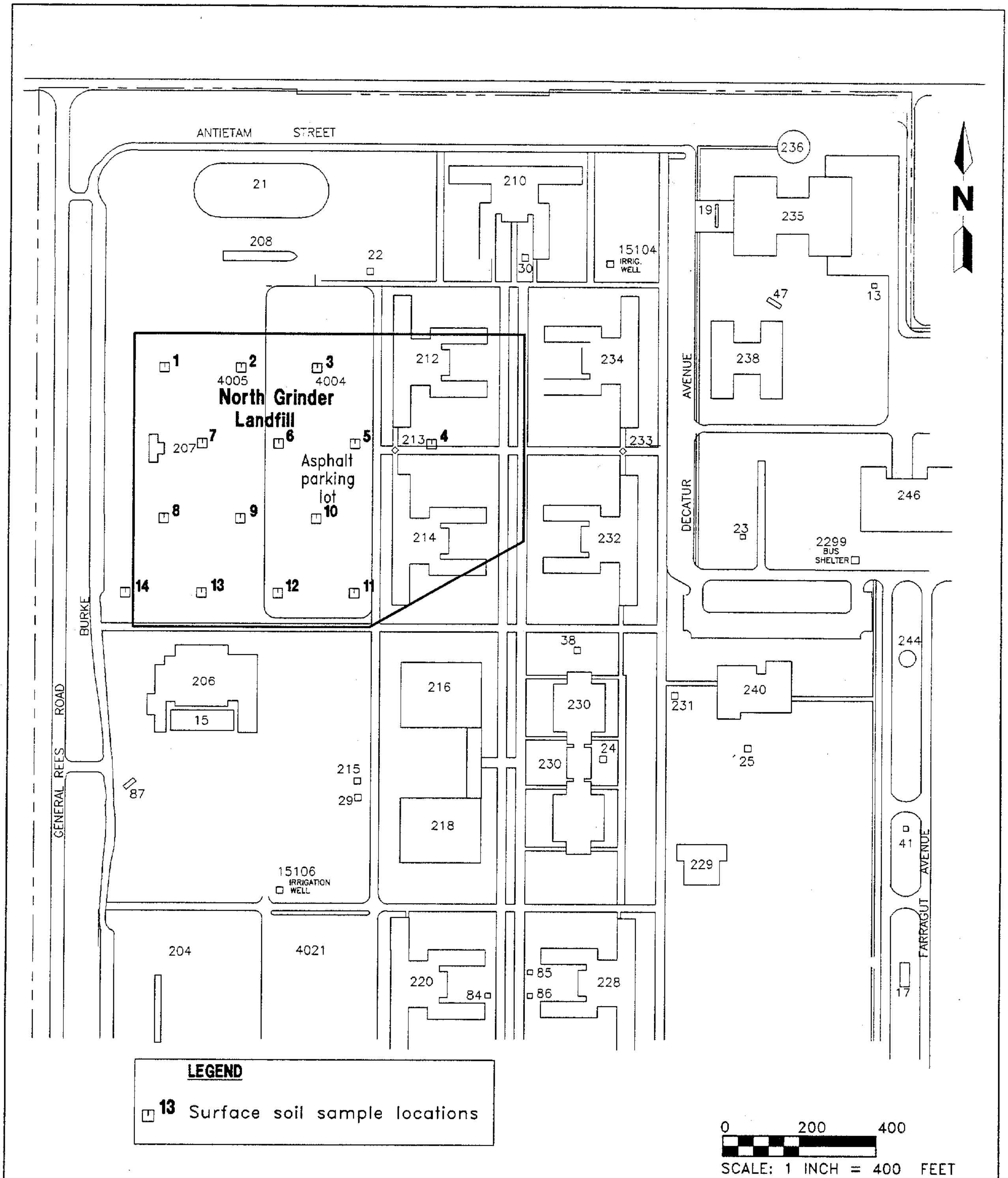


FIGURE 2-8
SURFACE SOIL SAMPLE LOCATIONS

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

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ORLANDO, FLORIDA

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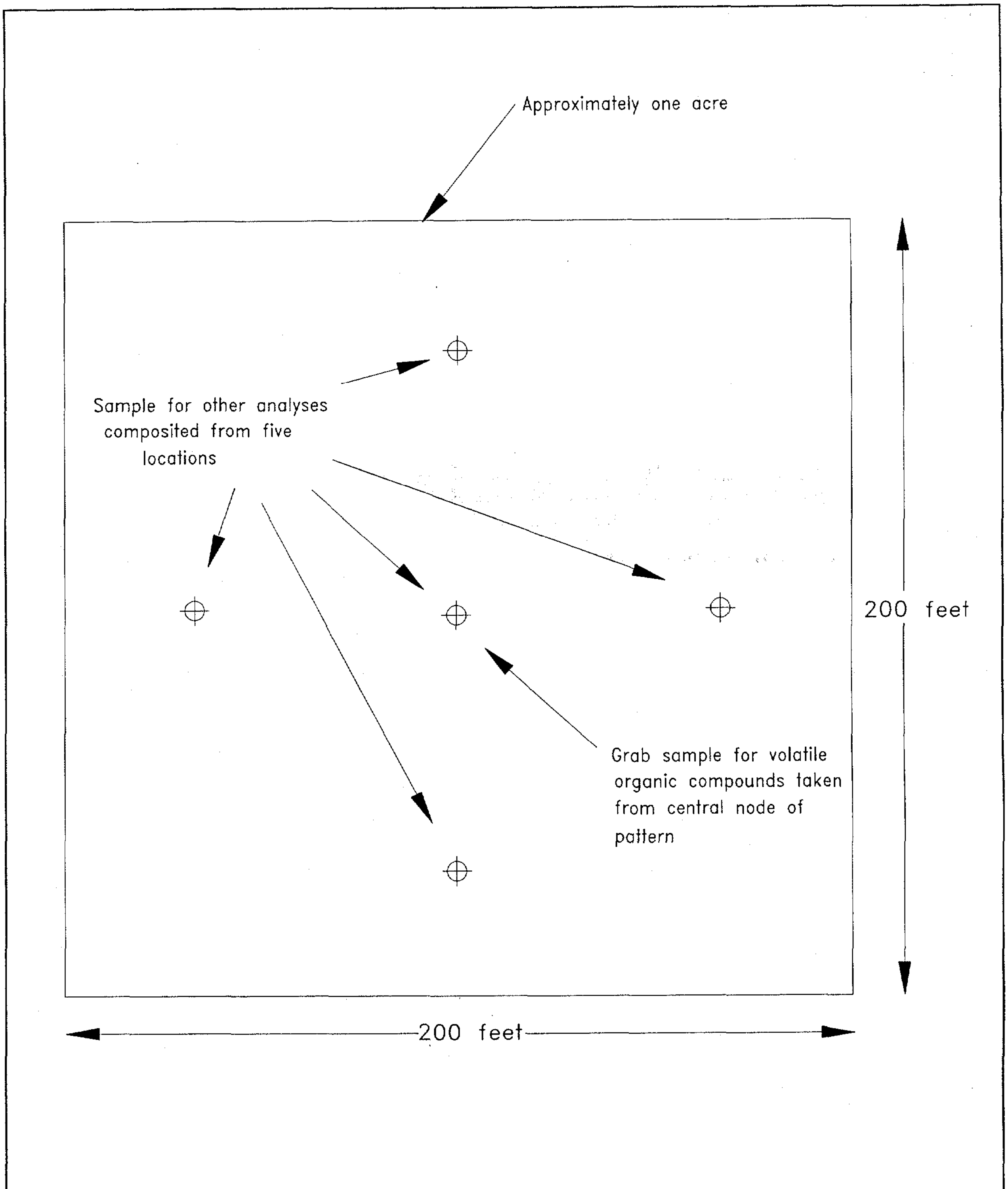

FIGURE 2-9
COMPOSITE PATTERN FOR SURFACE SOIL SAMPLING

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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Prior to sample collection, water was pumped from the well with a peristaltic pump at a very low-flow rate (less than 1 liter per minute [ℓ/min]) and with minimal drawdown. The field parameters of the groundwater (temperature, pH, specific conductance, and turbidity) were checked along with the water level and flow rate regularly during the purging process. Purging continued until stable parameters (pH, temperature, specific conductivity) had been achieved. This was to ensure that groundwater representative of the aquifer was collected for analysis. When field parameters had stabilized, the samples were collected by connecting the tubing to a stopper in a glass container. A peristaltic pump was used to draw a vacuum on the container. When the container had filled, the various sample bottles were filled. VOC samples were collected after the other samples by stopping the pump, pulling the tubing to the surface, and decanting water from the tubing into the sample vials.

Copies of the monitoring well sampling logs are provided in Appendix G.

All of the groundwater samples collected during the first sampling event were analyzed for TAL metals, TCL organics, and gross alpha and gross beta (Table 2-2). Four monitoring wells (OLD-U1-03C, OLD-U1-14B, OLD-U1-26B, and OLD-U1-27C) were later resampled during the week of October 16, 1995, because of elevated radiological parameters. The new samples were analyzed for gross alpha and gross beta as well as specific radionuclides including cesium-137, potassium-40, radium-226 and -228, thorium-227, -228, -230, and -232, and uranium-234 and -238.

To test the hypothesis that microbial activity at the fringes of the landfill is causing elevated radiological activity observed in several wells, additional field parameters and analyses were completed on groundwater samples collected on February 27, 1996, from wells OLD-U1-01A, OLD-U1-02B, OLD-U1-03C, OLD-U1-06C, OLD-U1-13A, OLD-U1-14B, OLD-U1-15C, OLD-U1-26B, and OLD-U1-27C. Analyses included pH, conductivity, oxidation-reduction potential (Eh), dissolved oxygen (DO), methane, total suspended solids (TSS), and percent volatile suspended solids (VSS).

Monitoring wells OLD-U1-28B and OLD-U1-29C were sampled on August 28, 1996, for TAL metals and gross alpha and gross beta.

<u>2.2.3 Surface Water and Sediment Sampling</u> No surface water or sediment sampling was completed during this remedial investigation. There are no known areas adjacent to the landfill that may have received stormwater runoff from the landfill. Approximately one-half of the area over the former landfill is paved, and the remaining portion of the landfill consists of well-maintained grass with no signs of vegetation stress. Surface water and sediment sampling were to have been completed only as a contingency in the event that groundwater analyses from monitoring wells indicate that the surficial aquifer or underlying aquifers are contaminated and it is likely that contaminants have migrated to adjacent surface water bodies.

Table 2-2
Analytical Program Summary

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Sample Identification	CLP/TCL VOCs	CLP/TCL SVOCs	CLP/TAL Metals	CLP/TCL Pesticides/PCBs	Herbicides	TPH	Radionuclides[1]	Other Secondary Parameters[1]
Surface Soil (from landfill cover)	14	14	14	14	14	14		
QC Samples								
Duplicate	2	2	2	2	2	2		
Matrix Spike	1	1	1	1	1	1		
Matrix Spike Duplicate	1	1	1	1	1	1		
Total Soil	**18**	**18**	**18**	**18**	**18**	**18**		
Groundwater	27	27	58	27	27	27	40	13
QC Samples								
Duplicate	3	3	3	3	3	3	3	3
Matrix Spike	2	2	2	2	2		2	
Matrix Spike Duplicate	2	2	2	2	2		2	
Other QC Samples								
Trip Blanks	17							
Equipment Blank	3	3	3	3	3		2	
Field Blank	1	1	1	1	1			
Total Water	**55**	**38**	**69**	**38**	**38**	**30**	**49**	**16**

[1] *See Appendix I-1 for details on particular radionuclides and secondary parameters analyzed in groundwater samples and the methods used for each analyte/compound.*

Number of water samples indicated for TAL Metals include filtered and unfiltered metals analysis.

Notes: CLP = contract laboratory program.
TCL = target compound list.
VOCs = volatile organic compounds.
SVOCs = semivolatile organic compounds.
TAL = target analyte list.
PCBs = polychlorinated biphenyls.
TPH = total petroleum hydrocarbons
QC = quality control.

3.0 REGIONAL AND SITE-SPECIFIC SETTING CONDITIONS

The following section describes the regional and site-specific physical characteristics of the area, including the physiography, climate, surface water hydrology, surface soil, geology, hydrogeology, demography, and local ecology. The information presented here was gathered from surface and subsurface exploration, field observations, sample collection, and review of available published and unpublished data.

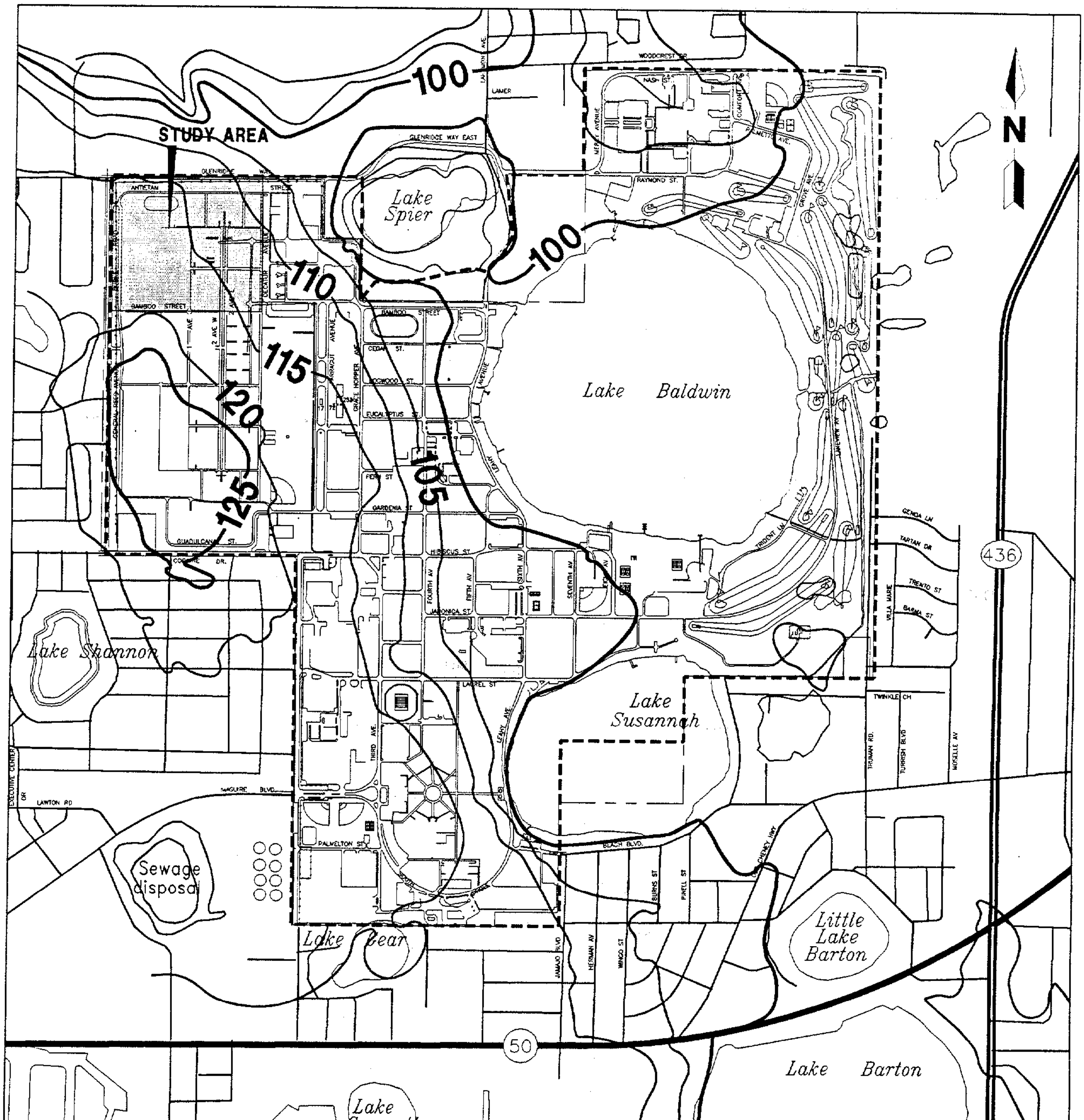
3.1 PHYSIOGRAPHY. Orange County, Florida, is situated within the Atlantic Coastal Plain physiographic province as defined by Brooks (1971). Most of the city of Orlando, and all of the Main Base facilities at NTC, Orlando, is contained within the highland topographic region, where elevations are generally greater than 105 feet above mean sea level (msl) (Figure 3-1). The land surface across most of the area is generally flat, but the higher ground elevations exist in the west side of the county and decrease gradually eastward. The elevation ranges from near 175 feet above msl in the western part of the county to approximately 100 feet above msl in the east.

The physiographic foundation of central Florida is the Florida Structural Platform, upon which Cretaceous, Tertiary, and Quaternary-aged carbonates have been deposited. The carbonates are overlain by unconsolidated clastic sediments composed primarily of clay to sand-sized grains and organic material. Dissolution along the upper surface of the underlying carbonates has resulted in the present landform, which is characterized by closed surface depressions and, if the water table is of sufficient elevation, shallow sinkhole lakes.

At the Main Base, the surface elevation decreases from approximately 125 feet above msl in the northwest corner to approximately 91 feet above msl at Lake Baldwin. The ground surface in the OU 1 study area gently slopes from the southwest to the northeast. The elevation ranges from approximately 120 feet above msl in the southwest corner to 110 feet above msl in the northeast corner. There are no surface features of significance within the study area.

3.2 CLIMATE. The climate of the Orlando area is characterized as humid and semitropical. According to the U.S. Department of Commerce (Local Climatological Data Survey, 1994), the average annual temperature is approximately 71.5 degrees Fahrenheit (°F). The range in daily average temperatures varies from approximately 50 °F in January to 80 °F in July. The prevailing winds blow from the west and south. The average annual rainfall in Orange County is 51.4 inches. Most of the rainfall occurs during afternoon thundershowers during the period from June through September. During the summer months, thunderstorms occur at a frequency of every other day and may yield several inches of rainfall. Rainfall amounts from thunderstorms vary widely. Winters typically are mild and dry. Potential evaporation for the area is estimated at a maximum value of 46 inches per year based on meteorological factors such as solar radiation, wind movement, air temperature, and humidity.

The Orlando area is subject to tropical storms and tornadoes. Tropical storms are likely to occur between June through November. Tornadic activity occurs on



LEGEND

— 100 — Surface elevation contour (feet, mean sea level)
Contour interval = 5 feet

0 1000 2000
SCALE: 1 INCH = 2000 FEET

FIGURE 3-1
TOPOGRAPHIC MAP

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

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ORLANDO, FLORIDA

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a relatively limited basis and is associated with both thunderstorms and tropical storms. The greatest impact from tropical storms is from prolonged rains and high tides, which cause flooding. Tropical storms that produce such flooding are considered equivalent to storm events of 100-year frequency.

3.3 SURFACE WATER HYDROLOGY. Surface drainage is poorly developed across most of the undeveloped areas of central Florida, but generally flows toward the south and east. Surface water runoff from the Main Base flows through the storm drainage system and small intermittent streams to Lake Susannah and Lake Baldwin, and eventually to the Little Econlockhatchee River, located approximately 4 miles to the east (Figure 3-2). The Little Econlockhatchee River flows northeastward and eventually drains into the St. Johns River. All surface waters in the vicinity of NTC, Orlando are classified by the State of Florida as Class III waters suitable for fish and wildlife propagation and water contact sports (Department of Navy [DON], 1992).

Surface water runoff from OU 1 is controlled by a storm sewer system that diverts stormwater from the asphalt parking lot covering a portion of the landfill to Lake Baldwin. The pavement prevents stormwater from coming into contact with landfill materials prior to being discharged into Lake Baldwin. The remainder of the landfill is a flat, grass-covered field with no drainage ditches. A shallow swale along the western boundary of the site controls surface runoff from General Rees Road, but the swale does not intersect the groundwater table. Therefore, there are no known pathways for potentially contaminated surface water runoff at the landfill to enter nearby aquatic habitats.

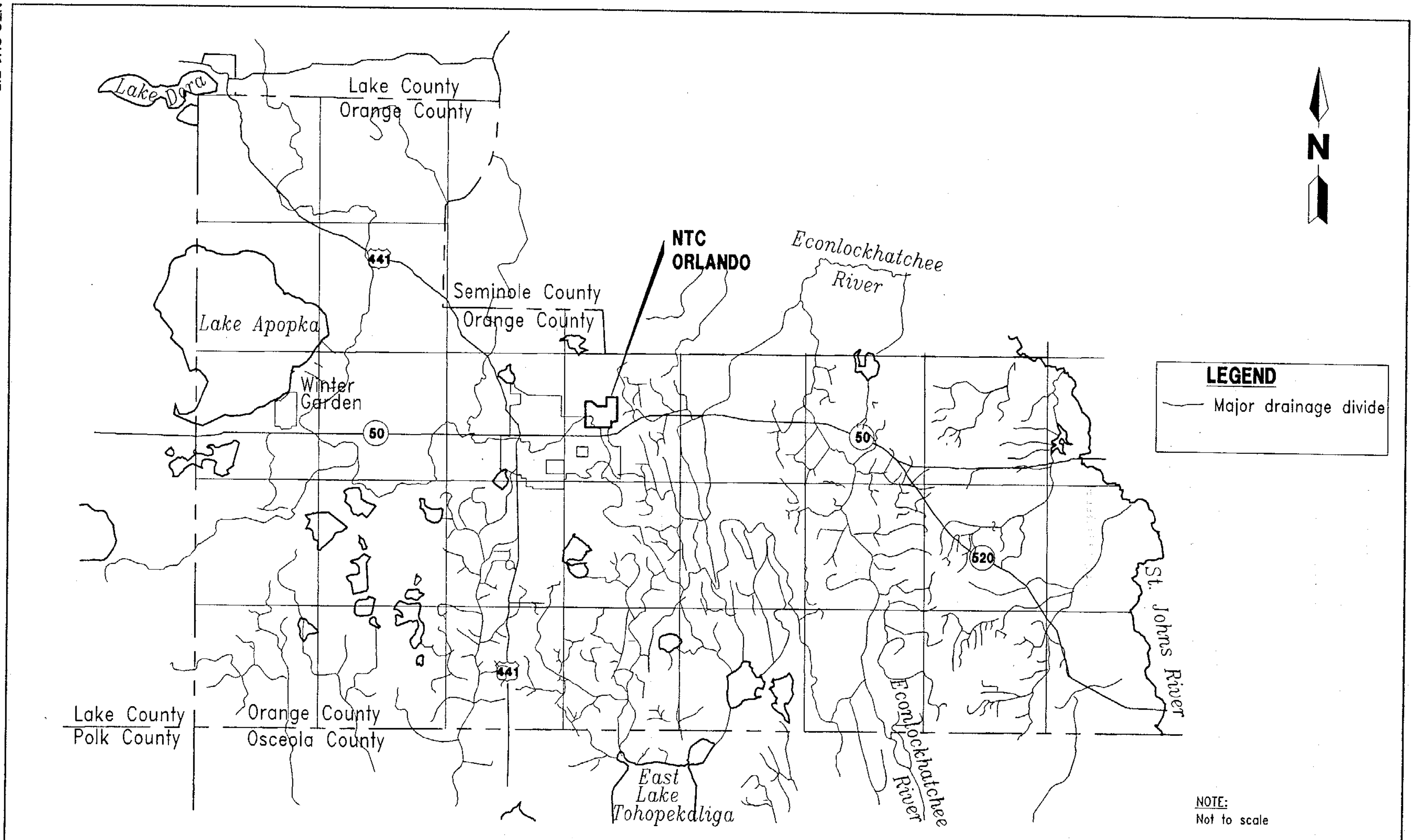
As with most of the surface water bodies in central Florida, the majority of the subcircular lakes in the vicinity of NTC, Orlando are a result of sinkhole activity. These lakes develop when dissolution of the underlying limestone creates cavities, which upon collapse allow unconsolidated Hawthorn Group and surficial sediments to slump downward. The resulting depression in the land surface may intercept the water table of the surficial aquifer and create a sinkhole lake. In some instances, these sinkhole lakes allow hydraulic connection between the surficial and Floridan aquifers. Surface water bodies downgradient of OU 1 are Lake Spier and Lake Berry.

3.4 SURFACE SOIL. The native soil at the Main Base is composed predominantly of sand-sized particles, which were deposited as marine terraces (Lichtler, et al., 1968). According to the U.S. Soil Conservation Service (U.S. Department of Agriculture, 1989), the surface soil can be divided into four distinct units:

- St. Lucie Fine Sand
- Zolfo Fine Sand
- Pomello Fine Sand
- Smyrna Fine Sand

The lateral limits of each of these units are provided on Figure 3-3.

The St. Lucie Fine Sand is native to the uplands and ridges that occupy the central part of the state. This soil drains moderately well and sometimes exists with an organic-rich layer from 30 to 50 inches bls.



Source:
United States Geological Survey, 1968

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FIGURE 3-2
SURFACE WATER AND DRAINAGE MAP

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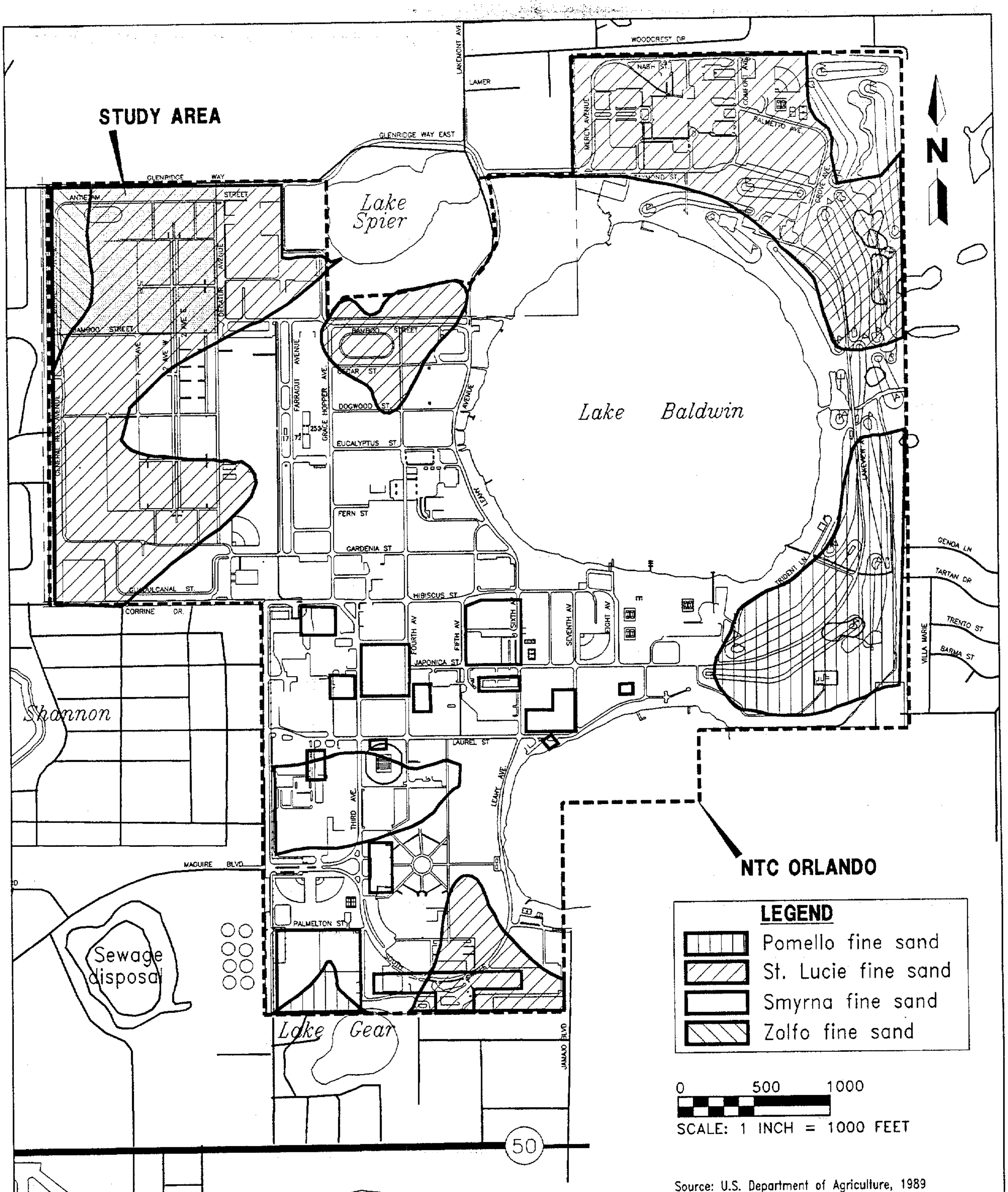

FIGURE 3-3
GENERAL SOILS MAP

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The Zolfo Fine Sand is also an upland soil but is typically more varied in nature with respect to its draining capabilities (poor to moderate) and composition (some areas are sandy throughout, some areas have an organic-rich subsoil, and in some areas this unit is sandy to depths of 40 inches bls with a loamy subsoil).

The other two units are not present at OU 1. The majority of the naturally occurring surface soil at OU 1 is the St. Lucie type soil. The Zolfo Fine Sand occurs in a limited area along the western boundary of the study area. However, in the area of the landfill, the soil is fill material.

3.5 GEOLOGY.

3.5.1 Regional The upper 2,000 feet or so of the subsurface in central Florida is divided into three separate lithologic units:

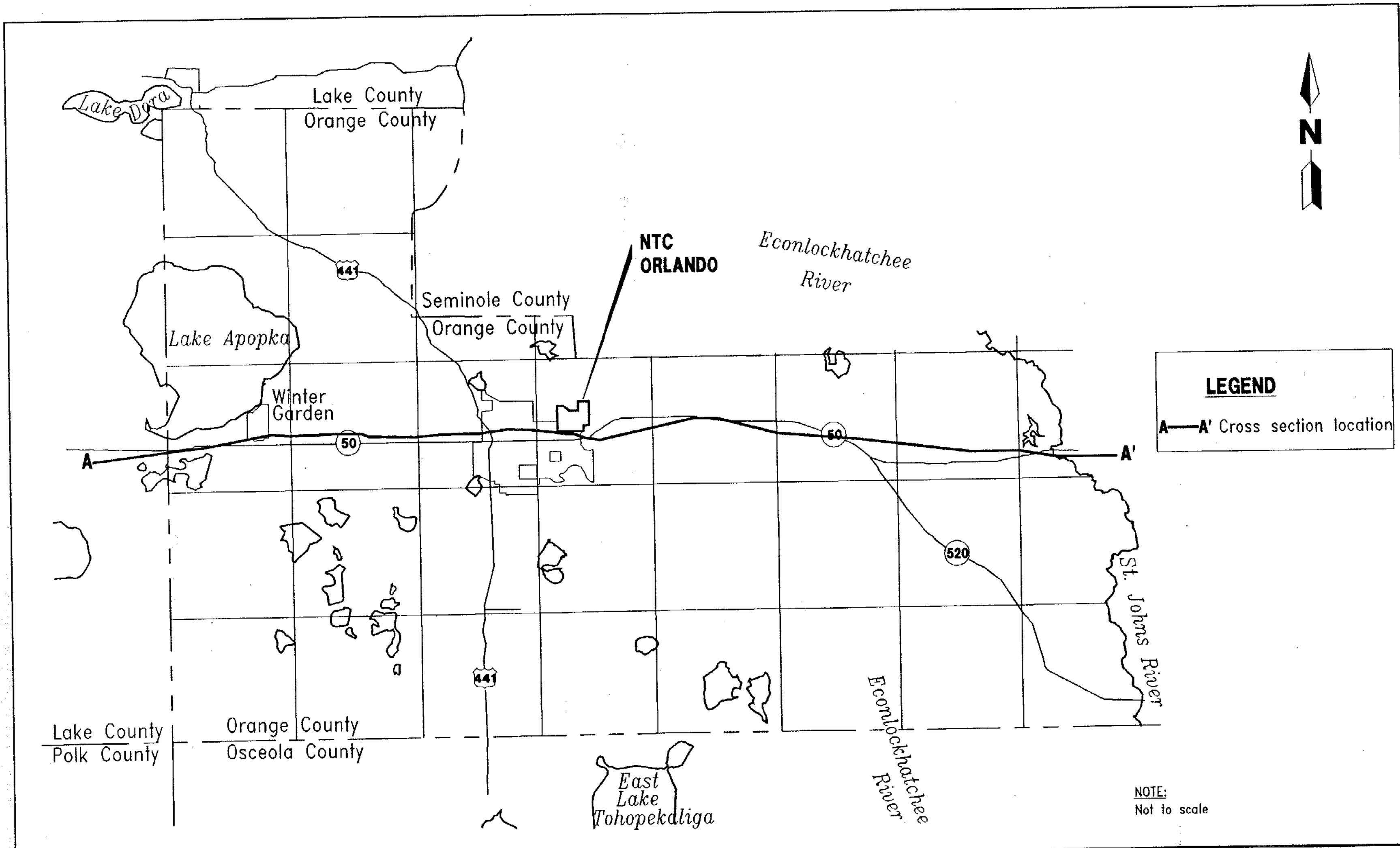
- The surficial deposits are a thin (generally less than 100 feet) sequence of undifferentiated terrace deposits of Recent and Pleistocene age.

- The underlying Hawthorn Group is a thin (generally less than 100 feet) sequence of mixed unconsolidated clastic material and carbonates of Miocene age.

- The Hawthorn overlies a thick (more than 1,200 feet) sequence of Eocene-age marine carbonates (Figures 3-4 and 3-5). The carbonate sequence is divided into three units: the Ocala Group, the Avon Park Limestone, and the Lake City Limestone (Figure 3-6). The major regional characteristics of these units are addressed in detail below.

3.5.1.1 **Surficial Deposits** The surficial deposits form the uppermost stratigraphic unit in the study area. Sediments of this unit were deposited along Pleistocene and Recent marine terraces. According to Lichtler (et al., 1968), these sediments consist predominantly of quartz sand with varying amounts of silt and clay-sized grains, and shell fragments. The lithology of these deposits varies laterally and vertically in most areas. Red iron oxide-cemented fine sand sediment, referred to locally as "hardpan", is common in the upper reaches of the surficial deposits. The sediments range from 50 to 100 feet thick over most of the region. The thickest accumulation of sediments exists along the ridge of the Florida peninsula and thins toward the coast.

3.5.1.2 **Hawthorn Group** The Hawthorn Group is typically described as a gray-green calcareous, phosphatic sandy clay, and clayey sand interbedded with thin discontinuous lenses of phosphatic sand, phosphatic sandy limestone, limestone, and dolostones. The limestone and dolostone lenses are thicker and more prevalent near the base of the Hawthorn. Phosphate is present throughout the sediment of the Hawthorn Group. The most common carbonate components of the Hawthorn Group are dolomite and dolosilt. Clay minerals associated with the Hawthorn Group sediments include smectite, illite, palygorskite, and kaolinite (Scott, 1988).



Source:
Lichtler, et al, 1968

FIGURE 3-4
REGIONAL GEOLOGIC CROSS SECTION LOCATION MAP

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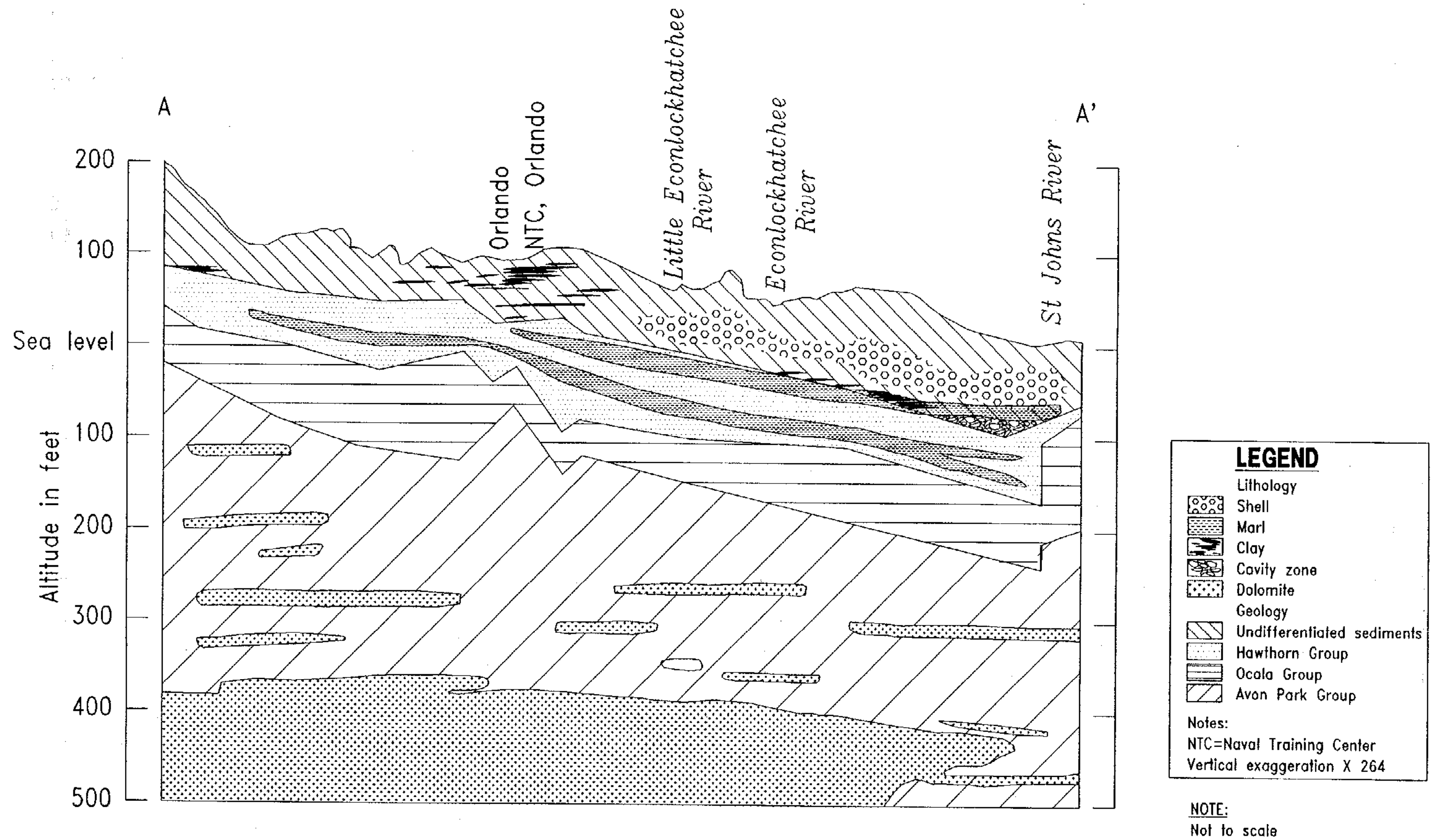

Source:
Lichtler, et al, 1968

FIGURE 3-5
REGIONAL GEOLOGIC CROSS SECTION

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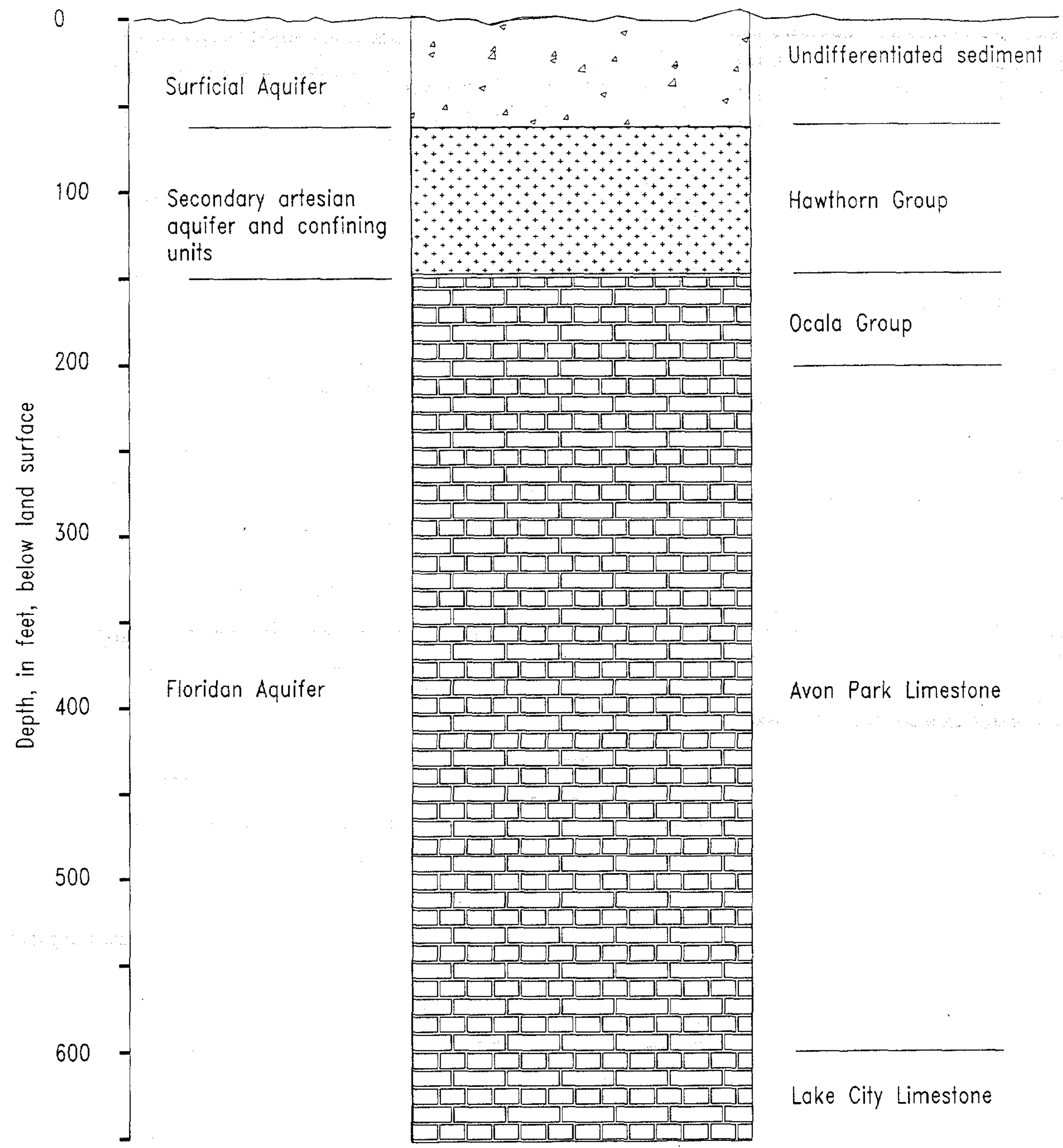

Source: Lichtler, et al, 1968

FIGURE 3-6
GENERALIZED HYDROSTRATIGRAPHIC COLUMN

REMEDIAL INVESTIGATION
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The Hawthorn Group has a variable thickness due to both its erosional surface and the erosional surface of the underlying Ocala Group. The unit is absent in most of Volusia County due to erosion. The Hawthorn Group ranges in thickness from a feather edge along the structural highs it dips away from (Ocala Uplift and Sanford High) to 900 feet in the Okeechobee Basin in southern Florida. In central and southern Florida, the unit thickens progressively southward. In Orange County, the Hawthorn Group averages approximately 50 to 100 feet in thickness. North of Orange County, the Hawthorn thickens toward the Jacksonville Basin in northeast Florida, reaching 500 feet.

3.5.1.3 **Marine Carbonate Sequence** The marine carbonate sequence consists of three units: the Ocala Group, the Avon Park Limestone, and the Lake City Limestone.

The Ocala Group consists of cream to tan, fine- to medium-grained, soft to hard, limestone, which is locally dolomitic. This unit varies in thickness from 0 feet (not present) to 125 feet. The Ocala Group is further divided into the Crystal River Formation, the Williston Formation, and the Inglis Formation. The Crystal River Formation is a white to cream, chalky, massive fossiliferous limestone and is the shallowest Eocene formation underlying the area. The Williston Formation, which lies conformably between the overlying Crystal River Formation and the underlying Inglis Formation, is a tan to buff, granular limestone. The Inglis Formation, of early late Eocene age, is lithologically a tan to buff, calcitic limestone that is very similar to the Williston Formation (Litchler, 1968).

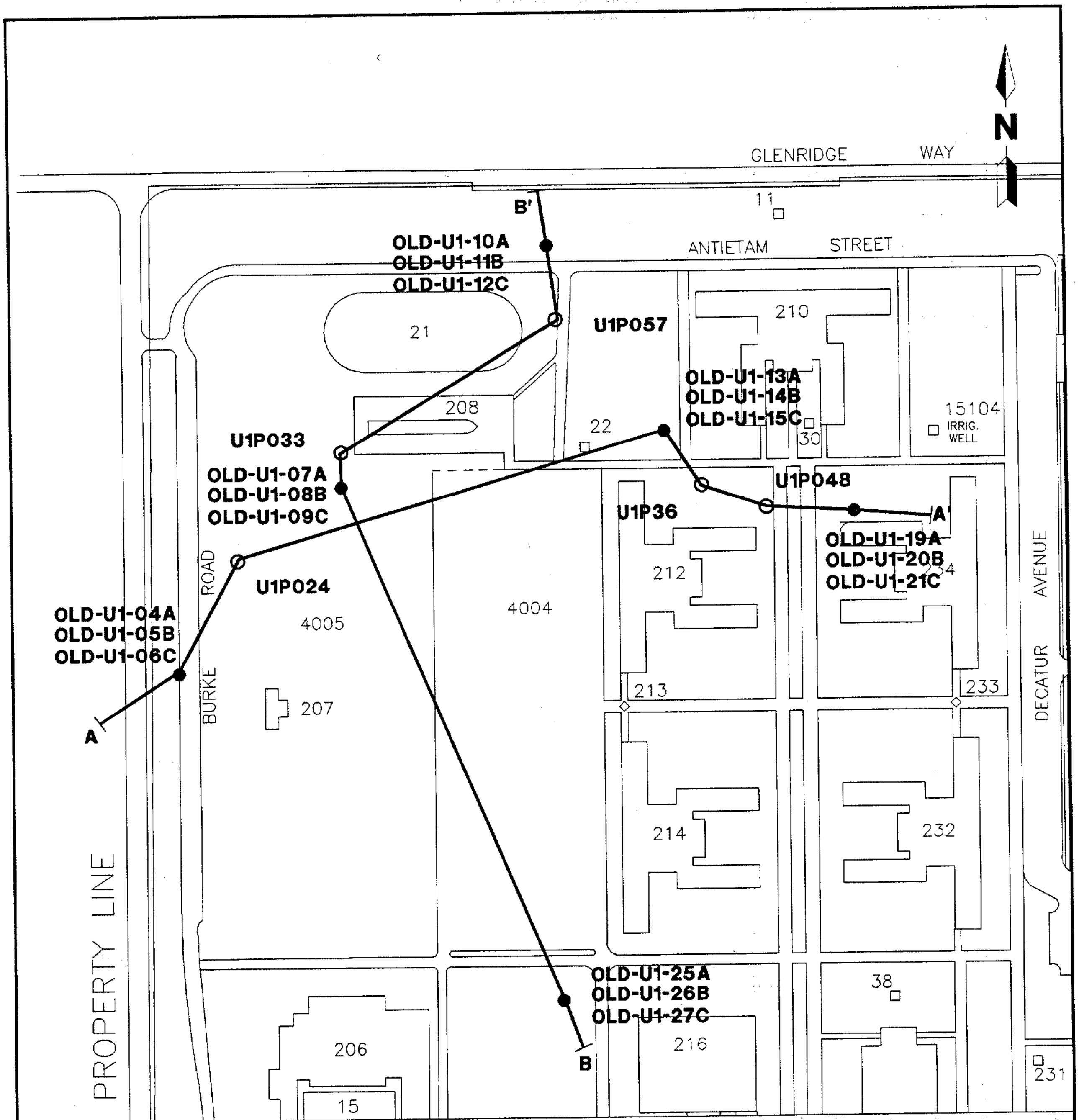
The Avon Park Limestone, of late middle Eocene age, unconformably underlies the Ocala Group, and is composed of an upper section of cream to tan, granular limestone with abundant cone-shaped foraminifera and a lower section of mostly dense, hard, brown, crystalline dolomite. In total, this unit ranges from 400 to 600 feet in thickness.

The Lake City Limestone unconformably underlies the Avon Park Limestone and is early middle Eocene in age. It consists of alternating layers of dark brown crystalline dolomite and chalky, fossiliferous limestone. The total thickness of this unit exceeds 700 feet.

Below the Lake City Limestone is the Oldsmar Limestone of early Eocene age. It consists of a cream to brown, soft, granular limestone and cherty, glauconitic, massive to finely crystalline dolomite.

3.5.2 Local The subsurface exploration activities performed during the field investigation were limited to the undifferentiated surface deposits and the upper 20 to 30 feet of the Hawthorn Group. Data collected from selected piezocone soundings and from standard penetration test (SPT) samples collected at each deep soil boring were used to construct east to west (A-A′) and north to south (B-B′) geologic cross sections (Figure 3-7). The cross sections are presented in Figures 3-8 and 3-9, respectively.

The undifferentiated surficial deposits can be generally divided into three separate units based on differing textural characteristics. The first unit is a light gray to brown silty fine sand. This unit was encountered throughout the upper 15 to 20 feet as well as the lower 10 to 20 feet of the surficial deposits. In general, this unit becomes finer grained on the east side of the study area



LEGEND

○	**U1P022**	Cone penetrometer location
●	**OLD-U1-01A**	Monitoring well location

FIGURE 3-7
LOCATION OF GEOLOGIC CROSS SECTIONS

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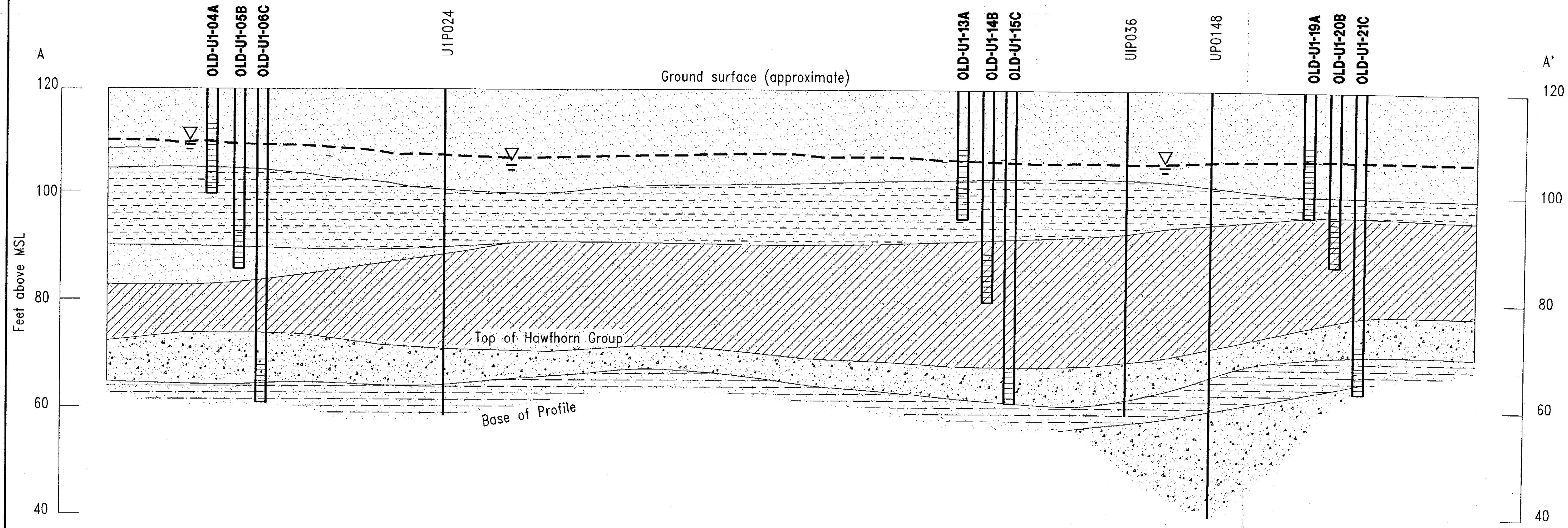

LEGEND

Water table surface

Lithologic Descriptions

Light gray to brown, silty, fine to medium-grained sand. Percentage of silt increases downward and eastward. (SP)

Light gray to dark brown, silty, fine-grained sand with intermingled layers of sandy silt. Partially cemented in places. (SP/SM).

Yellow to tan, silty, fine-grained sand with intermingled layers of gray silty clay. (SP/CL)

Grayish-green, silty, fine to coarse-grained sand with phosphate nodules and shell fragments. (SP)

Greenish-gray silty, clayey sand with intermingled layers of clay. (SC/CL)

MSL Mean sea level

Notes:

Horizontal exaggeration x 2.0

Vertical exaggeration x 1.25

FIGURE 3-8
EAST-WEST GEOLOGIC CROSS SECTION

REMEDIAL INVESTIGATION OPERABLE UNIT 1

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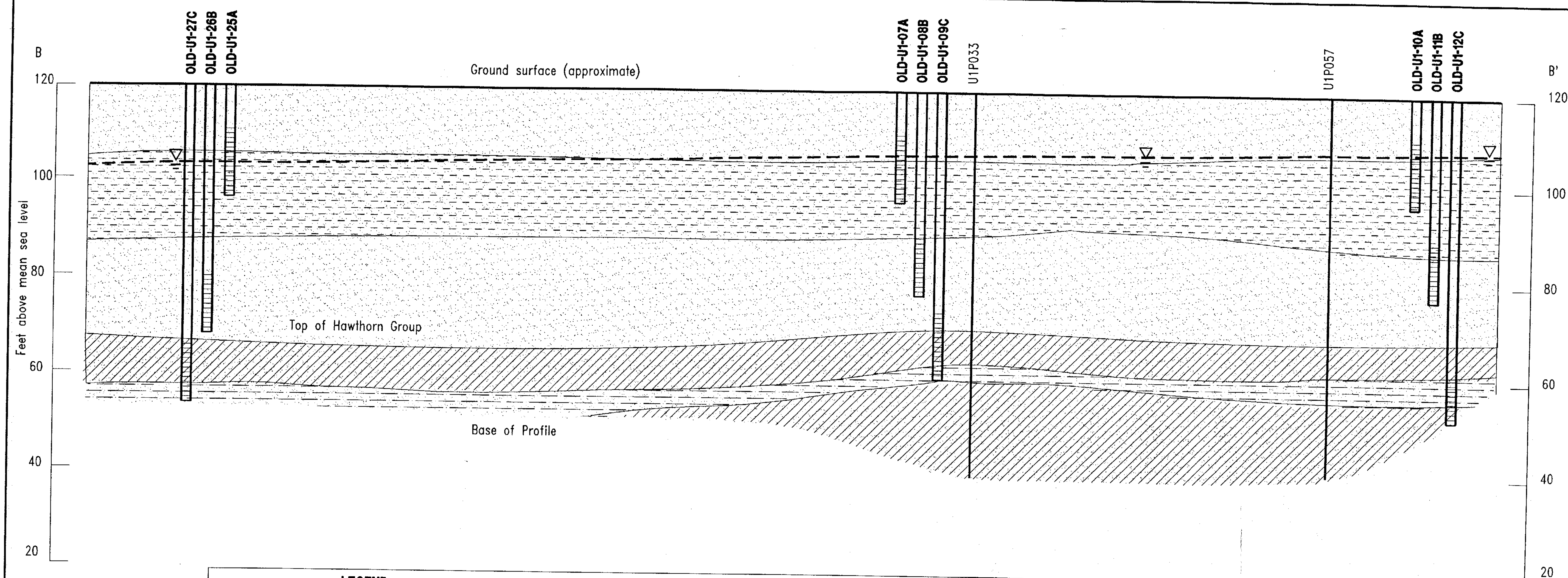

LEGEND

Water table surface

Lithologic Descriptions

Light gray to brown, silty, fine to medium-grained sand. Percentage of silt increases downward and eastward. (SP)

Light gray to dark brown, silty, fine-grained sand with intermingled layers of sandy silt. Partially cemented in places. (SP/SM).

Yellow to tan, silty, fine-grained sand with intermingled layers of gray silty clay. (SP/CL)

Grayish-green, silty, fine to coarse-grained sand with phosphate nodules and shell fragments. (SP)

Greenish-gray silty, clayey sand with intermingled layers of clay. (SC/CL)

MSL Mean sea level

Notes:

Horizontal exaggeration x 2.0

Vertical exaggeration x 1.25

FIGURE 3-9
NORTH-SOUTH GEOLOGIC CROSS SECTION

REMEDIAL INVESTIGATION OPERABLE UNIT 1

NAVAL TRAINING CENTER ORLANDO, FLORIDA

H:\OLD\GRINDER\176200\NAB-PS-CCK-NP-TB\12-13-96 and in the lower portion of the surficial section. The second unit is a light gray to dark brown silty fine sand with intermingled layers of sandy silt. At several locations, sections up to 2 feet thick within this unit were partially cemented. This unit retains a fairly constant thickness of 15 to 20 feet across the area but is thinner on the east and north portions of the area. The third unit is a yellow to tan silty fine sand with intermingled layers of gray silty clay. This unit extends from the southwest corner to the central portion of the study area. It reaches a maximum thickness of approximately 10 feet.

The upper part of the Hawthorn Group is generally divided into two units. The first is a greenish gray silty fine to coarse sand with phosphate nodules and shell fragments. This unit occupies the upper 10 to 15 feet of the Hawthorn Group in the study area. The second unit is a greenish gray silty clayey sand with intermingled layers of pure clay. This unit was penetrated from 3 to 5 feet.

The piezocone and SPT logs were used to measure the thickness of the undifferentiated surficial deposits (Figure 3-10). The surficial deposits are thickest in the southeast and northwest corners of the study area (55 to 60 feet thick) and thin to approximately 40 feet in the northeast. As the land surface is essentially flat across the study area, the isopach map represents the configuration of the surface of the Hawthorn Group. The surface is nearer to land surface, and hence at its highest elevation, where the deposits are thinner. Thus the surface of the Hawthorn has a high in the northeast corner and slopes toward the south and west.

3.6 <u>HYDROGEOLOGY</u>.

<u>3.6.1 Regional</u> According to regional literature, three distinct aquifer systems corresponding to the three major stratigraphic divisions are found in this area of central Florida: the surficial aquifer, an intermediate aquifer, and the Floridan aquifer system. The surficial, or shallow, aquifer is an unconfined porous flow system within the unconsolidated surficial deposits. The intermediate aquifer occurs where the clastic deposits of the Hawthorn Group are sufficiently permeable for groundwater flow. The bedding planes, cracks, and fissures within the Eocene carbonate sequence provide space for the groundwater of the Floridan aquifer system (Figure 3-6). Each aquifer is summarized below.

3.6.1.1 **Surficial Aquifer** The surficial aquifer exists throughout central Florida. Except for isolated areas where impermeable units may impede flow, the surficial aquifer is an unconfined water table system. Its boundaries generally correspond to those of the undifferentiated surficial deposits. The potentiometric surface of the surficial aquifer corresponds generally to the water table surface and ranges in depth from 5 to 15 feet bls. The water table is deepest (greater than 20 feet, on average) along the central Florida ridge (west of Orange County) and is shallowest near the coast. The water table surface fluctuates with seasonal variation in rainfall and proximity to recharge and discharge areas. Seasonal fluctuations range from a few feet in eastern Orange County, where the topography is predominantly flat, to approximately 15 feet in the highland areas (Litchler, 1968) on the west side of the county.

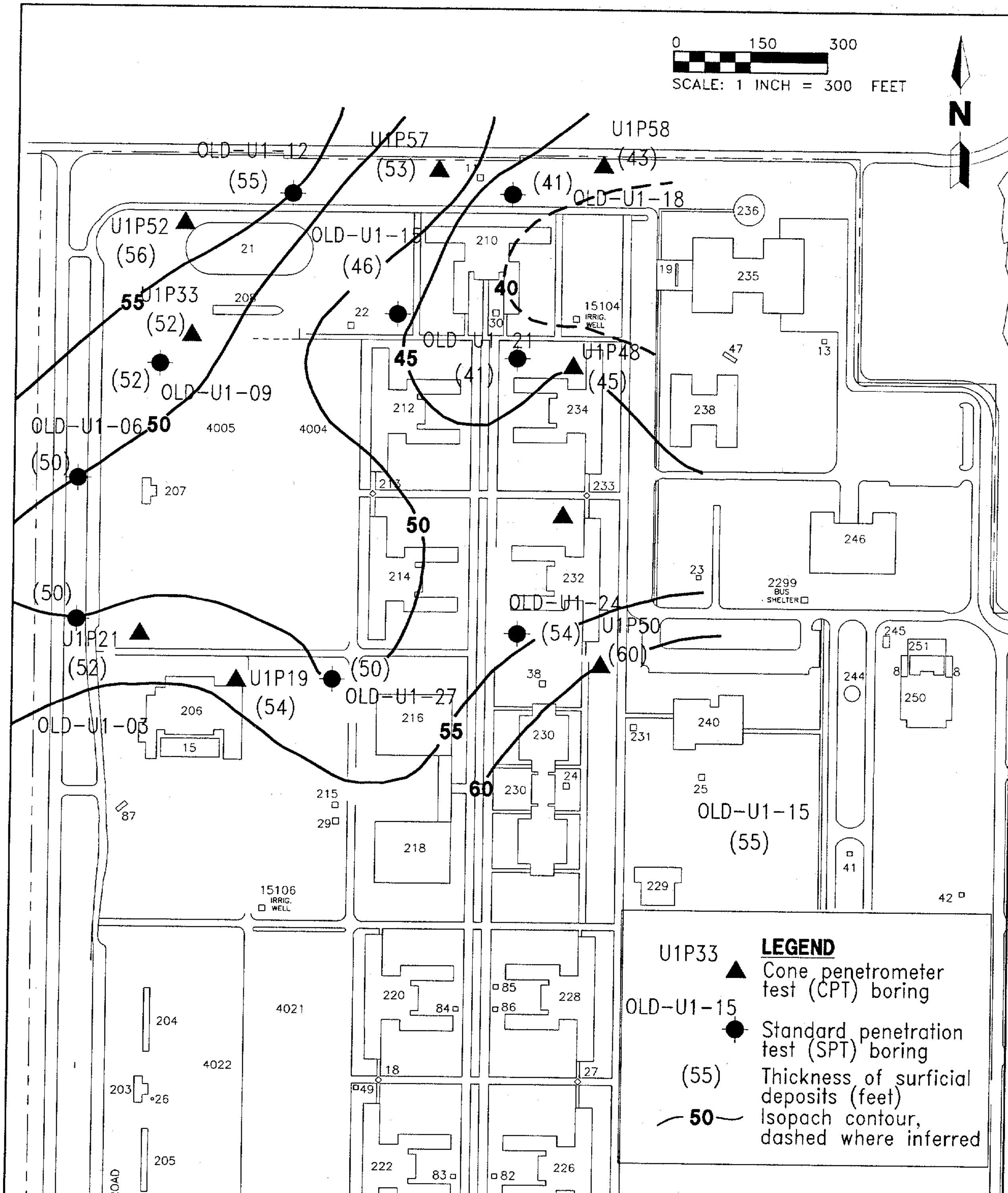

FIGURE 3-10
ISOPACH MAP OF UNDIFFERENTIATED DEPOSITS

REMEDIAL INVESTIGATION OPERABLE UNIT 1

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Topography is the predominant factor controlling the direction and velocity of the groundwater movement in the surficial aquifer. The general flow pattern in central Florida is eastward from the western highlands to the lower areas in the St. Johns River valley. The surficial aquifer is recharged primarily by local precipitation, with a limited exchange with the underlying intermediate and Floridan aquifers. Discharge of the surficial aquifer occurs by evapotranspiration, seepage into surface water bodies, and downward leakage into the underlying intermediate aquifer within the Hawthorn Group. Groundwater from the surficial aquifer is of marginal quality and is used primarily for irrigation purposes, not as a potable supply.

3.6.1.2 **Intermediate Hawthorn Aquifer** Groundwater within the intermediate aquifer is contained within the clastic lenses and limestones of the Hawthorn Group. Limestone layers in the upper part of the Hawthorn are typically the most productive. These coarser grained horizons are not continuous over the extent of the aquifer and are not extensively utilized. This aquifer is recharged from both the overlying surficial aquifer and underlying Floridan aquifer.

The Hawthorn Group generally acts as a confining bed to the Floridan aquifer and restricts the downward migration of water from the shallow aquifer.

3.6.2 Floridan Aquifer System The Floridan aquifer system is the principal source of fresh water in central Florida. The groundwater is contained within the sequence of Eocene carbonates (the Ocala Group, the Avon Park Limestone, and the lake City Limestone) and is capable of storing large amounts of groundwater. Transmissivities greater than 160,000 gallons per day per foot (g/d/ft) have been reported (Litchler, 1968). The two major water-producing zones in the Floridan aquifer in this region lie within the Avon Park Limestone and Lake City Limestone. The Avon Park zone lies anywhere from 150 feet to 600 feet bls, and the Lake City zone lies approximately 1,100 to 1,500 feet bls. The lower zone is the primary water supply source for the city of Orlando. The average concentration of total dissolved solids (TDS) in samples collected from Floridan wells in the area is approximately 400 milligrams per liter (mg/ℓ).

The Eocene carbonate sequence is folded and the units dip in a southerly direction throughout central Florida. Lateral groundwater flow within the Floridan aquifer generally conforms to the configuration of the producing zones and moves in the down-dip direction. Lateral flow is locally altered in areas where large amounts of water are pumped. The potentiometric surface of the Floridan aquifer exists at elevations ranging from 40 to 60 feet above msl in the Orlando area, resulting in a net downward hydraulic gradient between the Floridan and surficial aquifers and a net upward gradient between the Floridan and intermediate aquifers. Recharge to the Floridan aquifer is by direct rainfall in those areas of north Florida where the limestones of the aquifer outcrop at the land surface. Discharge occurs by pumpage from supply wells and leakage to the overlying intermediate aquifer.

3.6.3 Site-Specific Hydrogeology The hydrogeology at OU 1 was evaluated through preparation of potentiometric surface maps and permeability testing. These data were evaluated for the shallow, intermediate, and deep portions of the surficial aquifer.

3.6.3.1 Potentiometric Surface Mapping In order to identify surficial groundwater flow direction for the study area, water levels were measured at the monitoring wells installed at the study area. These data were used to map the potentiometric surface as depicted on Figure 3-11. The potentiometric surface generally mimics the topography of the area with the groundwater flow from the areas of the highest elevation along the west side of the base eastward toward Lake Baldwin and Lake Susannah. These lakes represent natural depressions in the potentiometric surface and groundwater flows toward them in a radial fashion. The configuration is consistent with that presented by published reports (Litchler, 1968).

In order to determine the seasonal variation of the potentiometric surface, water-level measurements were collected monthly. The data collected from the shallow monitoring wells during August 1995 and January 1996 (Tables 3-1 and 3-2) were used to construct the potentiometric maps presented on Figures 3-12 through 3-17, respectively. The potentiometric maps present the groundwater contours for the shallow, intermediate, and deep portions of the surficial aquifer. These data sets were selected because they were collected in the summer and winter months 6 months apart and, therefore, should be representative of the potentiometric surface at different points during the year.

A comparison of the potentiometric surface at its highest and lowest values indicates relatively little change in the lateral groundwater flow direction over time. For both cases, the groundwater flows generally in a north-northeast direction, with a more northerly flow on the south side of the area and northeasterly flow on the north side. The water-level fluctuation in the wells on the south and west sides of the study area between seasons is more pronounced (1 to 2 feet on average) than in the wells to the north and east. This variation in water-level range produces a variation in groundwater gradient with time, which alters the speed of groundwater flow through the area.

Water-level data from the monitoring wells show the well clusters located along the south and west sides of the study area have a significant range (greater than 10 feet at some clusters) of water-level elevations. When considered with the lithology of the study area, these data suggest that finer-grained sediments in the upper part of the surficial deposits are creating a perched water table condition to the southwest. The water-level elevations in the deep wells of these clusters may more accurately reflect the actual elevation of the local potentiometric surface.

When the water-level elevations are grouped by well completion interval, a variation in gradient is apparent. The shallow wells have a relatively steep horizontal gradient of 0.0075 feet per foot (ft/ft). The gradient across the intermediate depth zone is approximately 0.0067 ft/ft, and the gradient across the deep zone is approximately 0.0038 ft/ft. Because the water-level elevations of the shallow wells in the south and west may be influenced by perching, the deep well data may represent the closest estimate to the horizontal gradient across the study area.

3.6.3.2 Permeability Test Results Falling-head (slug-in) and rising-head (slug-out) tests were performed at each monitoring well where feasible, e.g., intermediate and deep wells. The rising-head test results (Table 3-2) are discussed below. The results appear to be consistent with the lithology of the

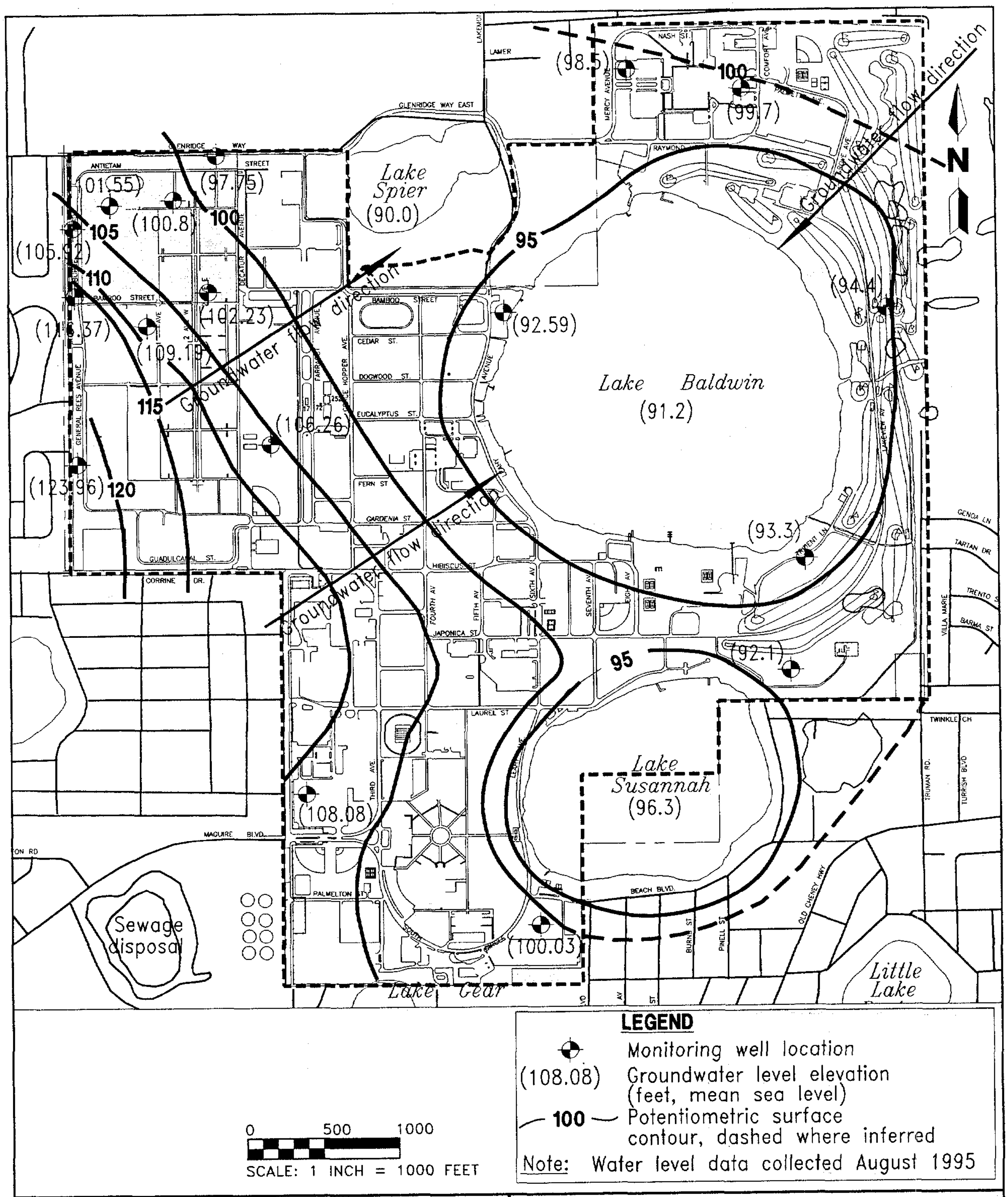

FIGURE 3-11
GENERALIZED POTENTIOMETRIC SURFACE MAP OF SHALLOW GROUNDWATER AQUIFER

REMEDIAL INVESTIGATION OPERABLE UNIT 1

NAVAL TRAINING CENTER ORLANDO, FLORIDA

Table 3-1
Water-Level Elevations - August 1995 and January 1996

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Well ID	Surveyed Position (TOC)			Depth to Water (feet below TOC) August 1995	Water-Level Elevation (msl) August 1995	Depth to Water (feet below TOC) January 1996	Water-Level Elevation (msl) January 1996
	Northing (ft)	Easting (ft)	Elevation (ft)				
OLD-U1-01A	1,541,971.15	547,139.37	119.72	3.35	116.37	4.72	115.0
OLD-U1-02B	1,541,978.44	547,139.49	119.68	7.47	112.21	9.33	110.35
OLD-U1-03C	1,541,984.68	547,139.61	119.61	16.8	102.81	14.79	104.82
OLD-U1-04A	1,542,375.99	547,135.13	117.33	11.41	105.92	10.83	106.50
OLD-U1-05B	1,542,382.52	547,135.25	117.35	16.44	100.91	12.69	104.66
OLD-U1-06C	1,542,388.89	547,134.60	117.19	14.5	102.69	12.51	104.68
OLD-U1-07A	1,542,778.51	547,302.04	116.26	14.71	101.55	12.54	103.72
OLD-U1-08B	1,542,783.48	547,306.18	116.08	14.72	101.36	12.70	103.38
OLD-U1-09C	1,542,787.94	547,310.43	116.12	14.41	100.71	12.96	103.16
OLD-U1-10A	1,543,160.06	547,833.59	113.95	14.76	99.19	13.07	100.88
OLD-U1-11B	1,543,163.50	547,827.89	113.81	14.63	99.18	12.97	100.94
OLD-U1-12C	1,543,171.05	547,833.21	113.76	14.63	99.13	12.97	100.89
OLD-U1-13A	1,542,802.29	548,013.76	114.17	14.06	100.08	12.18	101.99
OLD-U1-14B	1,542,805.31	548,016.03	114	14.23	99.77	12.05	101.95
OLD-U1-15C	1,542,809.78	548,018.87	113.99	14.13	99.86	12.05	101.94
OLD-U1-16A	1,543,166.03	548,399.26	109.66	11.91	97.75	10.78	98.88
OLD-U1-17B	1,543,170.54	548,404.08	109.63	11.9	97.73	10.78	98.85
OLD-U1-18C	1,543,175.26	548,409.38	109.35	11.66	97.69	10.44	98.89
OLD-U1-19A	1,542,697.76	548,351.99	112.9	13.66	99.24	11.81	101.09
OLD-U1-20B	1,542,702.51	548,353.99	112.78	13.54	99.24	11.69	101.09
OLD-U1-21C	1,542,706.99	548,355.76	112.81	13.65	99.16	11.78	101.03

See notes at end of table.

Table 3-1 (Continued)
Water-Level Elevations - August 1995 and January 1996

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Well ID	Surveyed Position (TOC)			Depth to Water (feet below TOC)	Water-Level Elevation (feet)	Depth to Water (feet below TOC)	Water-Level Elevation (feet)
	Northing (ft)	Easting (ft)	Elevation (ft)				
OLD-U1-22A	1,541,907.74	548,323.45	116.02	13.79	102.23	11.67	104.35
OLD-U1-23B	1,541,912.79	548,324.27	116.04	13.83	102.21	11.74	104.30
OLD-U1-24C	1,541,916.76	548,321.18	115.98	13.75	102.23	11.67	104.31
OLD-U1-25A	1,541,785.67	547,830.19	118.93	9.74	109.19	9.66	108.27
OLD-U1-26B	1,541,793.58	547,832.24	118.63	15.63	103	13.60	105.03
OLD-U1-27C	1,541,801.62	547,833.06	118.61	15.62	102.99	13.62	104.99

Notes: ID = Identification.
TOC = top of casing.
ft = feet.
msl = mean sea level.

Table 3-2
Permeability Testing Results

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Well ID	Slug Test Results (ft/min)		
	Falling Head (slug-in)	Rising Head (slug-out)	Average Falling Head and Rising Head
OLD-U1-01A	0.006318	0.003084	0.004701
OLD-U1-02B	0.002223	0.003831	0.003027
OLD-U1-03C	0.003797	0.004216	0.004006
Cluster Average	0.004113	0.003710	0.003911
OLD-U1-04A	0.002797	0.002799	0.002798
OLD-U1-05B	0.003251	0.003861	0.003556
OLD-U1-06C	0.004876	0.005074	0.004975
Cluster Average	0.003641	0.003911	0.003776
OLD-U1-07A	[1]0.007391	0.002665	--
OLD-U1-08B	0.003877	0.003960	0.003918
OLD-U1-09C	0.001607	0.001671	0.001639
Cluster Average	--	0.002765	--
OLD-U1-10A	0.001095	0.002810	0.001952
OLD-U1-11B	0.01662	0.014250	0.01543
OLD-U1-12C	0.01295	0.018801	0.01587
Cluster Average	0.04907	0.011951	0.03051
OLD-U1-13A	0.00772	0.00423	0.00597
OLD-U1-14B	0.03420	0.01554	0.02487
OLD-U1-15C	0.00840	0.00740	0.00790
Cluster Average	0.02516	0.00905	0.01710
OLD-U1-16A	0.00419	0.00155	0.00983
OLD-U1-17B	0.00426	0.00362	0.00394
OLD-U1-18C	0.00275	0.02798	0.01536
Cluster Average	0.00373	0.01102	0.00737
OLD-U1-19A	0.009964	0.01553	0.01771
OLD-U1-20B	0.004261	0.00362	0.00393
OLD-U1-21C	0.002751	0.00279	0.00277
Cluster Average	0.005658	0.00731	0.00814

See notes at end of table.

Table 3-2 (Continued)
Permeability Testing Results

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Well ID	Slug Test Results (ft/min)		
	Falling Head (slug-in)	Rising Head (slug-out)	Average Falling Head and Rising Head
Cluster Average	0.01705	0.01546	0.01625
OLD-U1-22A	0.00202	0.00124	0.00163
OLD-U1-23B	0.03614	0.02891	0.03252
OLD-U1-24C	0.01298	0.01622	0.01460
OLD-U1-25A	ND	0.006536	-
OLD-U1-26B	0.00209	0.002404	0.00225
OLD-U1-27C	0.00090	0.000986	0.00094
Cluster Average (Rising Head)	--	0.003306	0.00159
Site Average (Rising Head)	--	0.006384	-

[1] Results questionable due to low water level.

Notes: Average hydraulic conductivity value (slug-out) for all shallow wells: 0.004493 ft/min.
Average hydraulic conductivity value (slug-out) for all intermediate wells: 0.008448 ft/min.
Average hydraulic conductivity value (slug-out) for all deep wells: 0.009459 ft/min.

ID = identification.
ft/min = feet per minute.
-- = could not be calculated.
ND = not determined.

Source: ABB-ES, 1996.

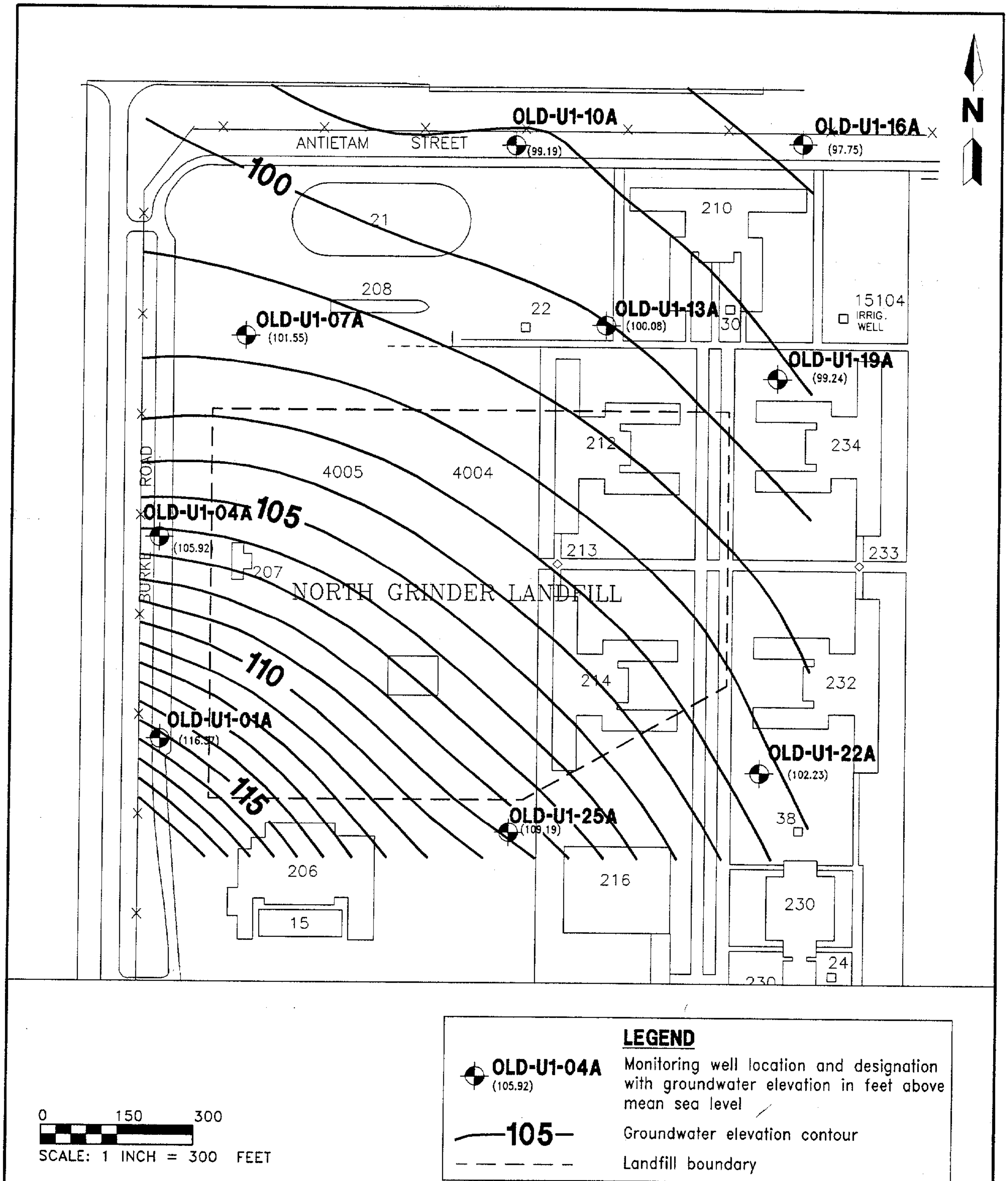

FIGURE 3-12
GROUNDWATER ELEVATION CONTOURS
UPPER PORTION OF SHALLOW AQUIFER
AUGUST 1995

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

H:\OLD\GRINDER\NGA-CONT\CCK-TB\ 12-13-96

NTC-OU1.RIR
PMW.12.96

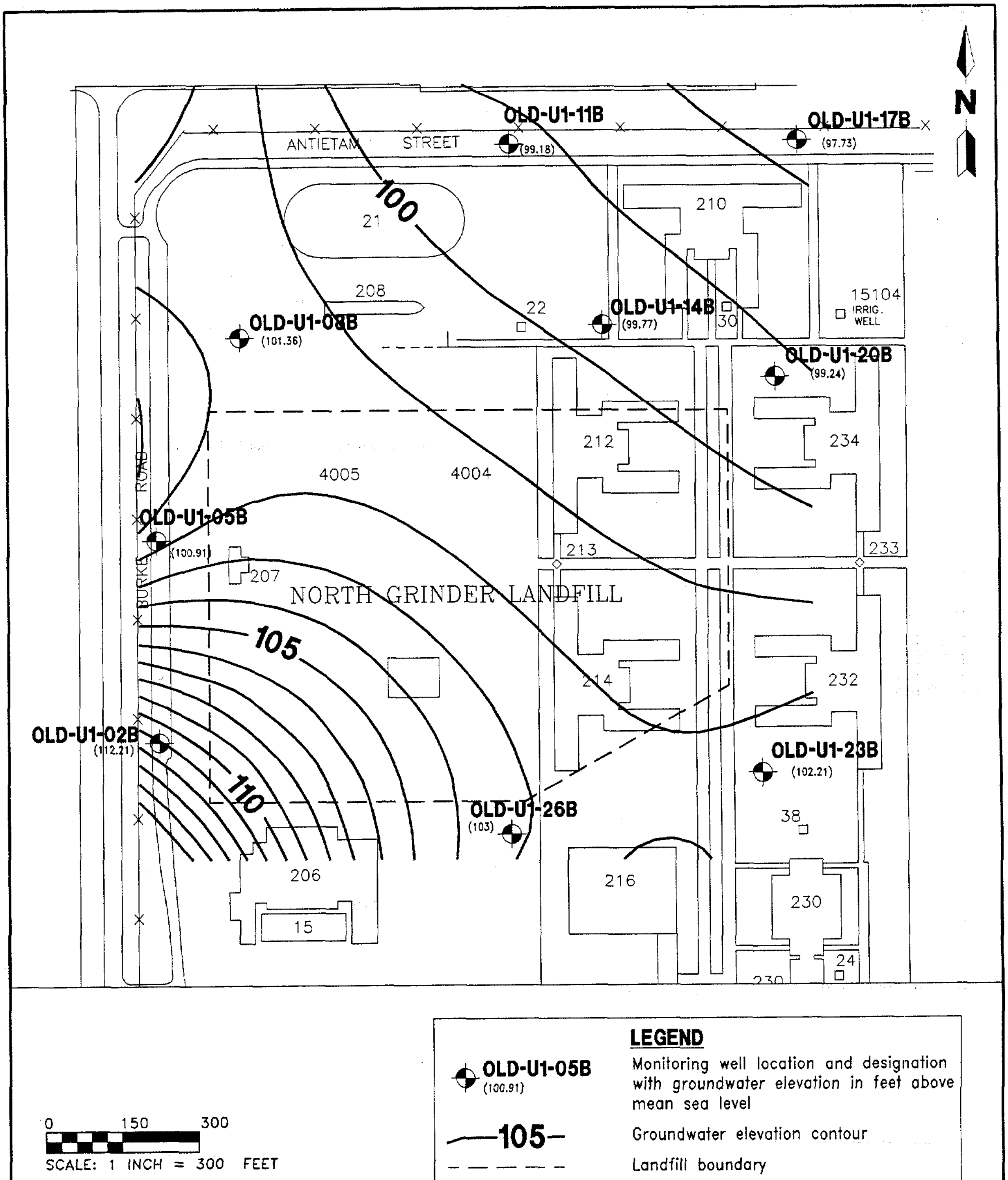

FIGURE 3-13
GROUNDWATER ELEVATION CONTOURS
INTERMEDIATE PORTION OF SHALLOW AQUIFER
AUGUST 1995

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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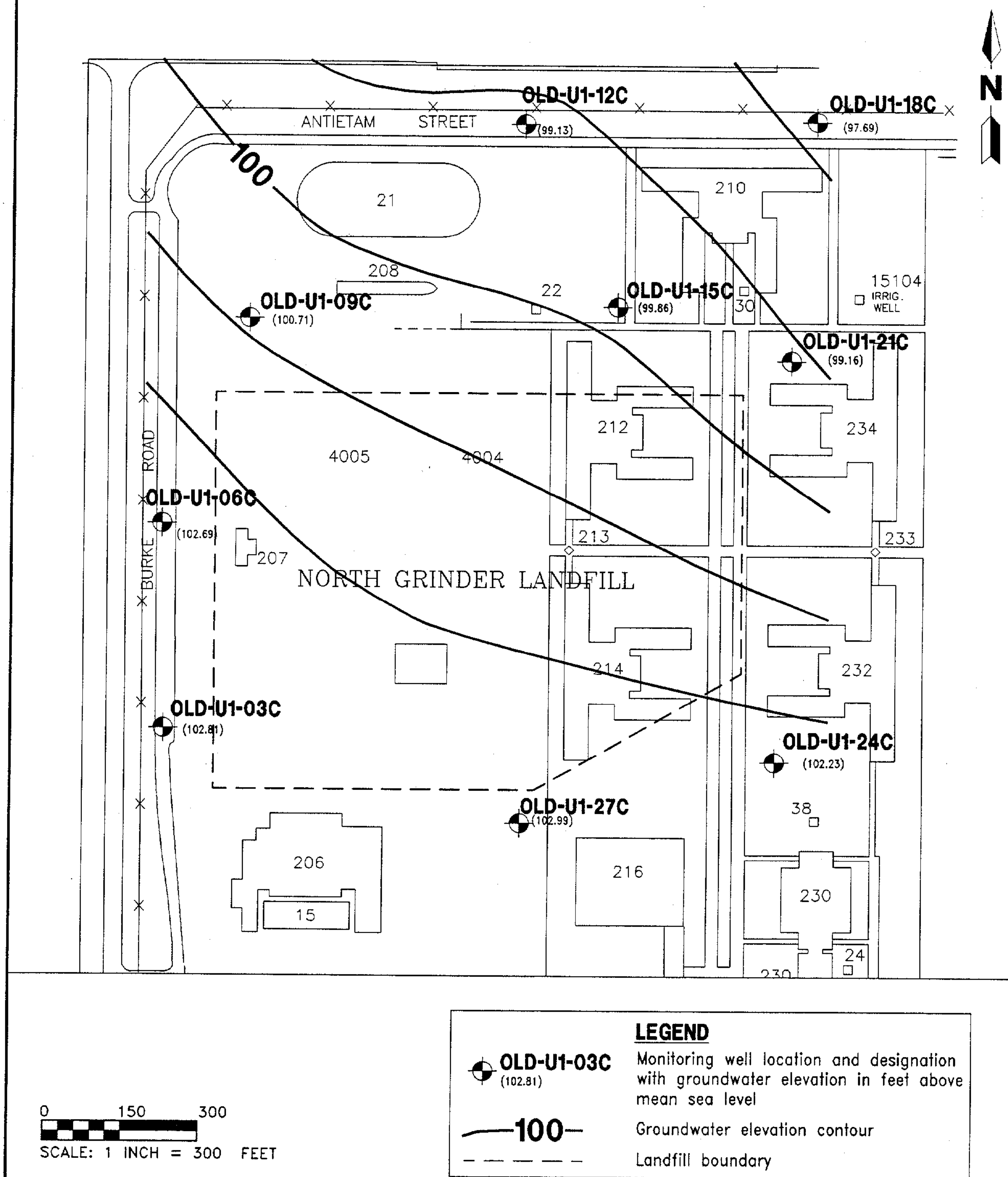

FIGURE 3-14
GROUNDWATER ELEVATION CONTOURS
DEEP PORTION OF SHALLOW AQUIFER
AUGUST 1995

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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NTC-OU1.RIR
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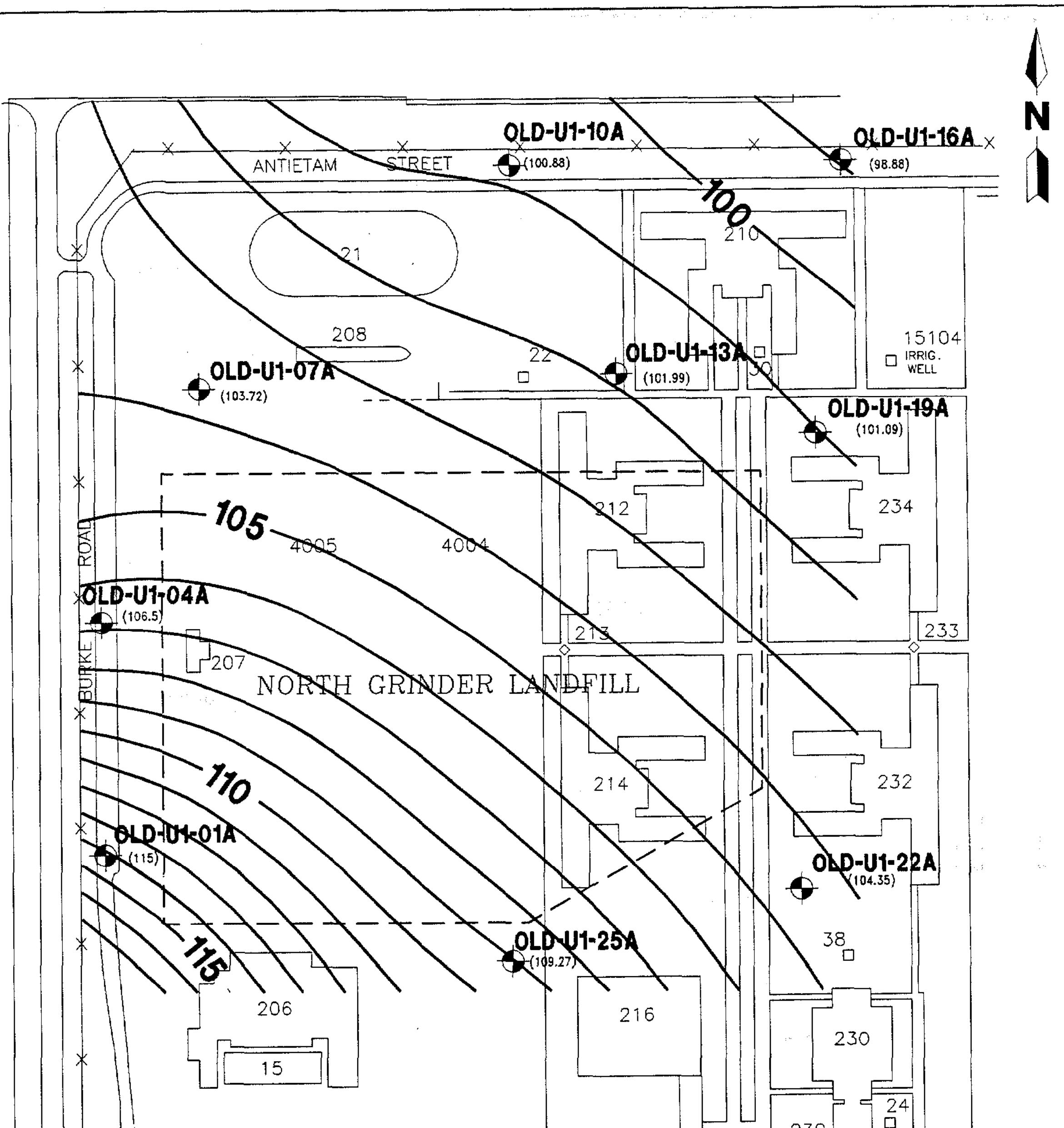

LEGEND

OLD-U1-04A (106.5) Monitoring well location and designation with groundwater elevation in feet above mean sea level

—105— Groundwater elevation contour

— — — — — Landfill boundary

0 150 300

SCALE: 1 INCH = 300 FEET

FIGURE 3-15
GROUNDWATER ELEVATION CONTOURS
SHALLOW PORTION OF SHALLOW AQUIFER
JANUARY 1996

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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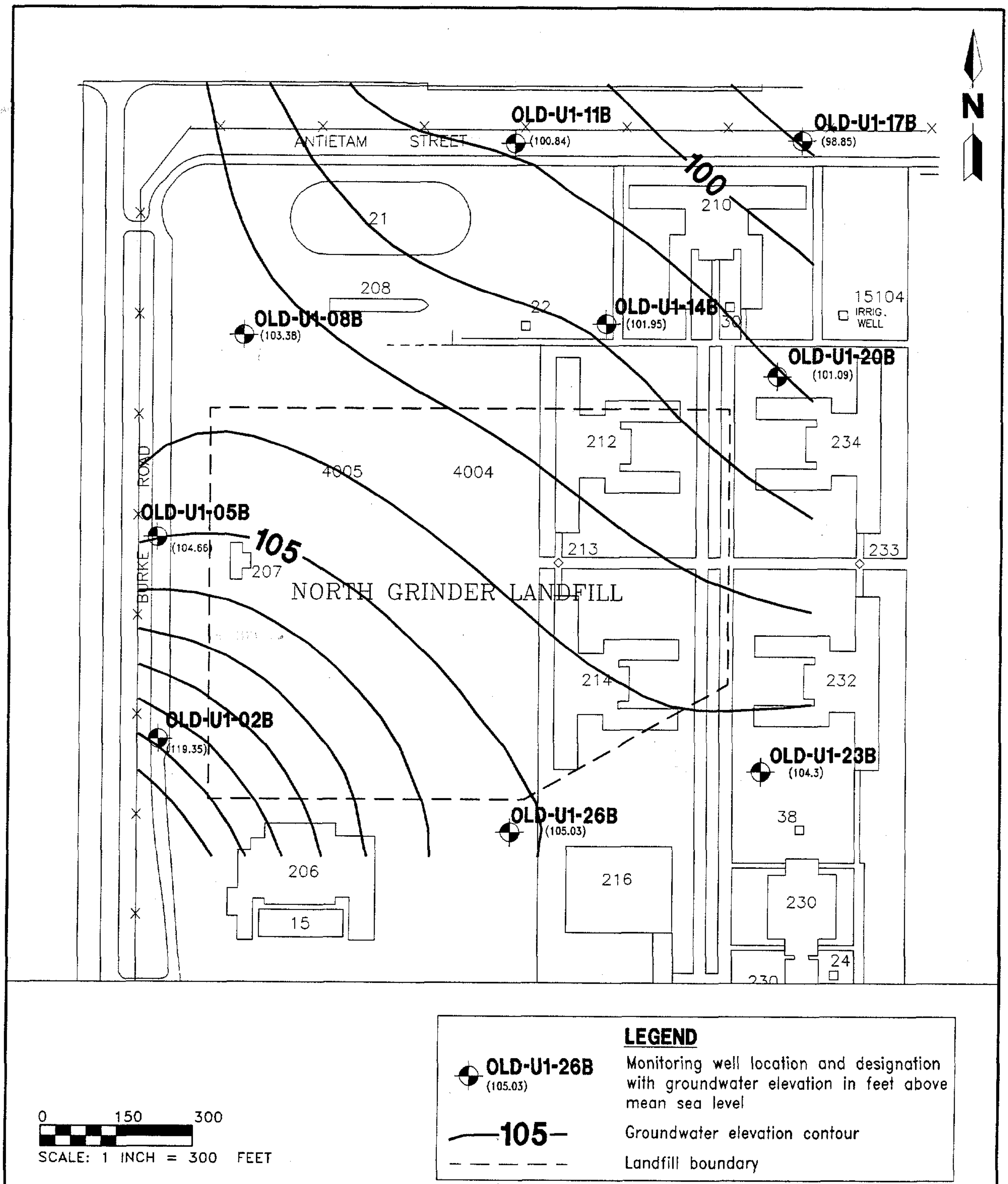

FIGURE 3-16
GROUNDWATER ELEVATION CONTOURS INTERMEDIATE PORTION OF SHALLOW AQUIFER JANUARY 1996

REMEDIAL INVESTIGATION OPERABLE UNIT 1

NAVAL TRAINING CENTER ORLANDO, FLORIDA

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NTC-OU1.RIR
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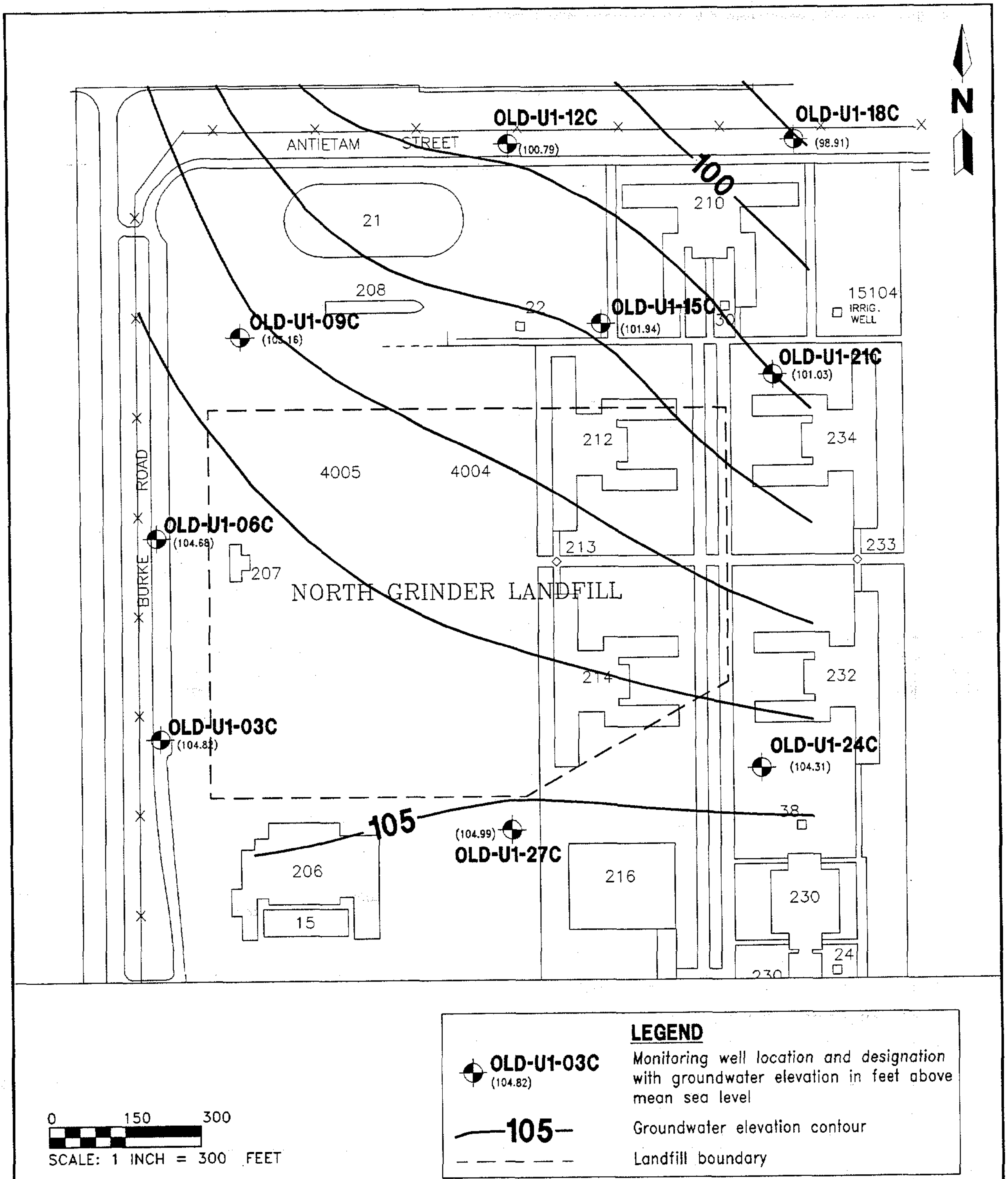

FIGURE 3-17
GROUNDWATER ELEVATION CONTOURS
DEEP PORTION OF SHALLOW AQUIFER
JANUARY 1996

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

REMEDIAL INVESTIGATION
OPERABLE UNIT 1

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

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NTC-OU1.RIR
PMW.12.96

area with higher values measured in wells screened in coarser-grained materials. The average permeability value for the rising-head test performed at the shallow wells is 0.004493 feet per minute (ft/min). The average permeability value at the intermediate depth wells is 0.008448 ft/min, and at the deep wells the average value increased to 0.009459 ft/min.

The average hydraulic conductivity values can be used in conjunction with the average horizontal gradient to determine the flow velocity at the varying depths of the surficial aquifer. The flow rate calculations are based on the following equation (Bouwer and Rice, 1976):

$$V=\frac{ki}{p}, \tag{1}$$

where: V = groundwater flow velocity (ft/min),
K = hydraulic conductivity (ft/min),
i = hydraulic gradient (ft/ft), and
p = porosity (unitless), assuming .30 for sand aquifers (Fetter, 1980).

Using this formula, the average flow rate for the upper part of the surficial aquifer in the study area is estimated at 0.000112 ft/min. In the intermediate depths of the aquifer, the average velocity increases slightly to approximately .00018 ft/min. For the deeper portions of the aquifer, the average velocity is .000119 ft/min. The higher calculated velocity in the intermediate zone reflects the steep horizontal gradient of the potentiometric surface and coarser-grained sediments improving hydraulic conductivity. The overall average for the surficial aquifer is 0.00014 ft/min in the study area. Assuming an average thickness of 50 feet for the surficial aquifer at OU 1, a transmissivity value of 625 square feet per day (ft^2/day) was calculated.

The permeability test plots and calculations are provided in Appendix H.

3.7 DEMOGRAPHY AND LAND USE. The Main Base occupies approximately 1,095 acres within the Orlando city limits and is composed mainly of operational and training facilities. These facilities are used for training new and recently graduated recruits, as well as enlisted and officer personnel in the nuclear engineering program. Land use at the Main Base is dominated by barracks, training facilities, administrative buildings, drill fields, and recreational areas. The population near the Main Base is transitional because of the influx of military personnel for temporary periods of time (1 to 3 years). There are approximately 15,820 enlisted personnel onsite at the Main Base at any given time, along with an average of 4 dependents, with approximately 50 children attending the day-care facility each day. There are two lakes within the Main Base property (Lakes Baldwin and Susannah) and four lakes (Spier, Forest, Shannon, and Gear) located in the residential areas adjacent to the facility (Figure 3-1).

The North Grinder parade field occupies approximately 15 acres in the northwest corner of Main Base, and Buildings 212 and 214 occupy an additional 7.5 acres. The parade field is used for the physical training, assembly, marching, and graduation ceremonies of the recruits. To the west of the parade field, across General Rees Road, the land is occupied by single family residences. Glenridge Elementary School is located to the north, across Glenridge Way.

3.8 ECOLOGICAL SETTING.

3.8.1 Terrestrial Habitat and Receptors Approximately 5 percent of the NTC, Orlando installation (roughly 100 acres basewide) is undeveloped, providing a limited amount of habitat for ecological receptors. The North Grinder Landfill is located in a developed portion of the base and is surrounded by small roads and buildings. Roughly one-half of the ground surface overlying the North Grinder landfill is currently either paved or covered by buildings. The remainder is covered by planted and mowed grass, with occasional ornamental shrubs.

Limited information is available regarding terrestrial fauna at NTC, Orlando. Because much of the land in the vicinity of the North Grinder Landfill is paved or covered by buildings, the potential wildlife habitat appears to be limited to the small areas of planted grasses and ornamental trees and shrubs.

Small mammals that may occur at the site include the eastern cottontail rabbit (*Sylvilagus floridanus*), hispid cotton rat (*Sigmodon hispidus*) and cotton mouse (*Peromyscus gossypinus*). Predatory mammals such as the red fox (*Vulpes vulpes*) and gray fox (*Urocyon cinereoargenteus*) may feed on small mammals at the base.

Birds of prey such as the black vulture (*Coragyps atratus*), turkey vulture (*Cathartes aura*), red-tailed hawk (*Buteo jamaicensis*), and red-shouldered hawk (*B. lineatus*) may forage for prey items in the vicinity of the landfill. Granivorous birds such as the mourning dove (*Zenaida macroura*) are likely to be found occasionally in the grassy areas or ornamental shrubs and trees that comprise the majority of habitats at the site. Other bird species that may occur at NTC, Orlando include the brown-headed cowbird (*Molothrus ater*), brown thrasher (*Toxostoma rufum*), bobwhite quail (*Colinus virginianus*), mockingbird (*Mimus polyglottus*), common grackle (*Quiscalus quiscula*), killdeer (*Charadrius vovoferus*), northern cardinal (*Cardinalis cardinalis*), blue jay (*Cyanocitta cristata*), rufous-sided towhee (*Pipilo erythrophthalmus*), common flicker (*Colaptes auratus*), and red-bellied woodpecker (*Centurus carolinus*).

Several species of venomous snakes may occur in the area, including the eastern coral snake (*Micururus fulvius fulvius*), dusky pygmy rattlesnake (*Sistrurus miliarus barbouri*), and eastern diamondback rattlesnake (*Crotalus adamanteus*). These snakes are among the top predators in the food chain at the installation. Rattlesnakes feed on rodents, birds, amphibians, and small reptiles. Coral snakes ingest other snakes, lizards, and amphibians.

3.8.2 Aquatic Habitat and Receptors All surface waters in the vicinity of NTC, Orlando are classified by the State of Florida as Class III waters, suitable for fish and wildlife propagation and water contact sports. Surface water runoff from the North Grinder Landfill reportedly drains via a series of storm drainage ditches to Lake Speir, which is approximately 1,300 feet to the east.

The small storm drainage ditches may, in some locations, provide limited habitat for populations of aquatic invertebrates, amphibians, and small fish species; great blue herons, which feed primarily on small fish and amphibians, could also forage in these ditches. The majority of aquatic habitat, however, is located in the series of lakes, ponds, and swamps located throughout other portions of the base. These lakes and ponds, and swamps with sufficient water, provide habitat for a number of fish species, including smallmouth bass (*Micropterus salmoides*), bluegill sunfish (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*), golden shiner (*Notemigonus crysoleuca*), yellow bullheads (*Ictalurus natalis*), and killifish (*Fundulus* spp.), as well as aquatic invertebrates (C.C. Johnson and Associates, 1985). According to the NTC, Orlando Master Plan Update (SOUTHNAVFACENGCOM, 1985), grass carp (*Ctenopharyngodon idella*) have been introduced into several of the larger lakes to control Florida elodea (*Hydrilla verticillata*), an invasive, rapidly growing aquatic weed that chokes waterways, rendering them impassable to boat traffic (C.C. Johnson and Associates, 1985).

Amphibians that may occur in the vicinity of the North Grinder landfill include frogs (e.g., members of the genera *Hyla*, *Rana*, and *Pseudacris*) and toads (*Bufo* spp.) as well as possibly some salamanders. The Florida cottonmouth (*Agkistrodon piscivorus*), a venomous aquatic snake inhabiting lakes, rivers, swamps, and ditches, also could occur in the ditches in the vicinity of the landfill. The cottonmouth feeds on fish, amphibians (e.g., frogs and salamanders), small- to medium-sized reptiles (e.g., lizards, small turtles, baby alligators), and small birds and mammals. Turtles and other aquatic and semiaquatic reptiles (e.g., the American alligator, *Alligator mississippiensis*) may occur in some of the lakes and other water bodies at the installation but are unlikely to occur in the vicinity of the North Grinder landfill.

3.8.3 Rare, Threatened, and Endangered Species A field survey to identify rare, threatened, and endangered species has not been completed at NTC, Orlando. Table 3-3 presents a list of species which have historically occurred at or in the vicinity of NTC, Orlando, based on the information available in the 1985 Master Plan Update (SOUTHNAVFACENGCOM, 1985) and in the IAS of NTC, Orlando (C.C. Johnson & Associates, 1985).

Based on a recent inquiry to the Florida Game and Fresh Water Fish Commission (FGFWFC), no State-listed rare or endangered species under their jurisdiction, including those listed in Table 3-3, have recently been documented as occurring at NTC, Orlando. However, the FGFWFC database is not inclusive of all Florida State-listed rare and endangered species. The FGFWFC noted that three bird species under their jurisdiction (limpkin [*Aramus guarauna*], least tern [*Sterna antillarum*], and the loggerhead shrike [*Lanius ludovicianus*]) were noted to be breeding in the vicinity of NTC, Orlando during the Florida Breeding Bird Atlas project undertaken from 1985 through 1991 (FGFWFC, 1996). The State and Federal status of these species is summarized in Table 3-4.

Information regarding rare, threatened, and endangered species was also requested and received from the Florida Natural Areas Inventory (FNAI, 1996). They reported two "Element Occurrence Records" mapped within a 2-mile radius of NTC, Orlando. These occurrences are summarized below in Table 3-5.

Additional information was requested and received from the U.S. Fish and Wildlife Service (USFWS, 1996). They provided a list of rare, threatened, and endangered

Table 3-3
Rare, Threatened, and Endangered Species

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Common Name	Scientific Name	Status	
		Federal	State
Florida mouse	*Podomys floridanus*	C2	SSC
Southeastern kestrel	*Falco sparverius paulus*	C2	T
Short-tailed snake	*Stilosoma extenuatum*	C2	T
Eastern indigo snake	*Drymarchon corais couperi*	T	T
Gopher tortoise	*Gopherus polyphemus*	C2	SSC
American alligator	*Alligator mississippiensis*	T(S/A)	SSC

Source: Florida Game and Freshwater Fish Commission (1991)

Notes: C2 = Federal candidate species.
SSC = Species of special concern.
T = threatened.
T(S/A) = Threatened due to similarity of appearance.

Table 3-4
Updated List of Rare, Threatened, and Endangered Species That May Occur at NTC, Orlando

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Common Name	Scientific Name	Status	
		Federal	State
Limpkin	*Aramus guarauna*	NL	SSC
Least tern	*Sterna antillarum*	E (specific states only; does not include Florida population)	T
Loggerhead shrike	*Lanius ludovicianus*	C2	NL

Source: Florida Game and Freshwater Fish Commission (1996).

Notes: NTC = Naval Training Center.
NL = not listed.
SSC = Species of special concern.
E = endangered.
T = threatened.
C2 = Federal candidate species.

Table 3-5
Elemental Occurrences of Rare, Threatened, and Endangered Species from the Florida Natural Areas Inventory

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Common Name	Scientific Name	Status	
		Federal	State
Bald eagle	*Haliaeetus leucocephalus*	T	T
Blackwater stream (a natural community)		NL	NL(S2)

Source: Florida Game and Freshwater Fish Commission (1996).

Notes: T = threatened.
NL = not listed.
S2 = Imperilled in Florida because of rarity.

species that may occur in Orange County (Table 3-6), but had no specific information regarding any occurrences at NTC, Orlando. The bald eagle and eastern indigo snake are two federally listed species that were identified by FGFWFC (1991, 1996) as possibly occurring near NTC, Orlando. Based on the limited habitat and developed nature of the North Grinder landfill, however, these species are unlikely to occur at or utilize this site.

Table 3-6
Federally Listed Threatened, Endangered, Candidate, and At Risk Species That May Occur in Orange County, Florida

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Common Name	Scientific Name	Federal Status
Bat, Rafinesque's Big-Eared (= Southeastern)	*Plecotus rafinesquii*	R
Bear, Florida Black	*Ursus americanus floridanus*	C1
Bear-grass, Britton's	*Nolina brittoniana*	E
Bear-grass, Florida	*Nolina atopocarpa*	R
Beetle, Scrub Palmetto Flower Scarab	*Trigonopelastes floridana*	R
Bonamia, Florida	*Bonamia grandiflora*	T
Caracara, Audubon's Crested	*Polyborus plancus audubonii*	T
Crayfish, Palm Springs Cave	*Procambarus acherontis*	R
Eagle, Bald	*Haliaeetus leucocephalus*	T
Frog, Florida Crawfish (= Gopher)	*Rana areolata aesopus*	R
Ixia, Fall-Flowering	*Nemastylis floridana*	R
Jay, Florida Scrub	*Aphelocoa coerulescens coerulescens*	T
Jointgrass, Piedmont	*Coelorachis tuberculosa*	R
Kestrel, Southeastern American	*Falco sparverius paulus*	R
Kite, Everglade Snail	*Rostrhamus sociabilis plumbeus*	E
Lizard, Florida Scrub	*Sceloporus woodi*	R
Lupine, Scrub	*Lupinus aridorum*	E
Spiny-pod, Florida	*Matelea floridana*	R
Moth, Eastern Beard Grass	*Atrytone arogos arogos*	R
Mouse, Florida	*Podomys floridanus*	R
Muskrat, Round-Tailed	*Neofiber alleni*	R
Orchid, Yellow Fringeless	*Platanthera integrilabia*	R
Pawpaw, Beautiful	*Deeringothamnus pulchellus*	E
Rail, Black	*Laterallus jamaicensis*	R
Rosemary, Large-Flowered	*Conradina gradiflora*	R
Sandlace	*Polygonella myriophylla*	E
Savory, Ashe's	*Calamintha ashei*	R
Skink, Sand	*Neoseps reynoldsi*	T
Snake, Eastern Indigo	*Drymarchon corais couperi*	T
Snake, Florida Pine	*Pituophis melanoleucus mugitus*	R
Snake, Short-Tailed	*Stilosoma extenuatum*	R
Sparrow, Bachman's	*Aimophila aestivalis*	R
Squirrel, Sherman's Fox	*Sciurus niger shermani*	R
Stork, Wood	*Mycteria americana*	E
Tortoise, Gopher	*Gopherus polyphemus*	R

See notes at end of table.

Table 3-6 (Continued)
Federally Listed Threatened, Endangered, Candidate, and At Risk Species That May Occur in Orange County, Florida

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Common Name	Scientific Name	Federal Status
Vervain, Tampa	*Verbena tampensis*	R
Whitlow-Wort, Papery	*Paronychia charkacea* = *Nyachia pulvinata*	T
Wild Buckwheat, Scrub	*Eriogonum longifolium* var. *g.* = *Eriogonum floridanum*	T
Willow, Florida	*Salix floridana*	R
Woodpecker, Red-cockaded	*Picoides borealis*	E

Source: U.S. Fish and Wildlife Service (1996). List dated September 1995.

Notes: R = At risk species (informal list) previously identified as category (C)2 candidates (formal list).
C1 = Candidate for which the U.S. Fish and Wildlife Service has enough information to propose listing but for which pre-listing recovery funds and actions may first be appropriate.
E = Endangered.
T = Threatened.

4.0 NATURE AND EXTENT OF CONTAMINATION

This chapter focuses on the nature and location of contaminants in the existing landfill cover material and groundwater, and assesses whether or not contamination has migrated from the landfill source areas. This discussion uses the information discussed in the earlier sections on regional and site-specific conditions (Chapter 3.0) and the physical and chemical data collected during the field investigations (Chapter 2.0).

All analytical data obtained from these investigations have been combined into a single, analytical database, following a review of data quality by means of data validation. Data quality indicators include the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the analytical data on a per-medium basis. In general, the combined data set complied with PARCC criteria and is considered acceptable for use in this RI and to support a potential feasibility study. The analytical data, including Sample Tracking Logs, Positive Detection Tables, Summary of Laboratory Analytical Tables, PARCC Reports, Statistical Evaluation, and Gross Radioactivity-Inorganic Comparisons are presented as Appendices I-1 through I-6, respectively.

The combined data set was also subjected to data evaluation. Data evaluation differs from data validation in that the latter deals only with the adherence of the analytical process to protocol specifications, whereas data evaluation considers the environment from which the analyzed sample was collected, the means of collection, as well as the characteristics of data considered to be within the same data set and knowledge of the compound's behavior in the area of the investigation. Data evaluation included the following:

- Evaluation for the presence of chemicals that may not be true detections and may have been introduced during decontamination, field sampling, or laboratory analysis (analytical and sampling artifacts). These chemicals include acetone, methylene chloride, toluene, 2-butanone, and five phthalate esters (butylbenzylphthalate, di-n-butylphthalate, di-n-octylbutylphthalate, diethylphthalate, and bis(2-ethylhexyl)phthalate) (USEPA, 1991b; 1988a). These contaminants, when analytical artifacts, are either introduced during analysis or during decontamination of sampling equipment. The lack of a discernable pattern of contamination, the lack of a potential source, or the presence of low levels (below practical quantitation limits) of these chemicals in some locations (especially without any other detection of a related compound, e.g., other ketones for acetone or other aromatics for toluene) may indicate that these chemicals are artifacts.

- Statistical evaluation of OU 1 inorganic data against the facility background data as published in the Background Sampling Report (ABB-ES, 1995a). The statistical evaluation approach is summarized in Section 4.1 and detailed in Appendix I-5.

A discussion of the contaminant sources is presented in Section 4.2. In Section 4.3, the nature and distribution of contamination is presented. Inorganic constituents were statistically evaluated against established background concentrations. Organic contaminants were compared to preliminary applicable or relevant and appropriate requirements (ARARs), and to-be-considered (TBC) requirements and guidances. These comparisons were made in order to distinguish those contaminants that are most likely site-related from those that are unrelated to past site activities. All contaminants detected at OU 1 are evaluated in terms of risk in Chapter 6.0. The information presented in this chapter is summarized in Section 4.4.

The nature and extent of contamination in the landfill soil cover are discussed first, followed by contamination in the groundwater beneath and around the landfill area. Within each of these media, analytical fractions are discussed in the following order: volatile organics, semivolatile organics, pesticides and PCBs, inorganics, and radiological parameters. Other analyses completed (water quality parameters, etc.) are discussed as applicable. Following the evaluation of each analytical fraction for a particular medium, a summary of relevant results and findings is presented. All positive detection tables and figures containing spatially significant analytical information are presented in Section 4.3, below.

<u>4.1 STATISTICAL EVALUATION APPROACH</u>. The statistical evaluation approach for OU 1 analytical data primarily uses nonparametric statistical methods, which include (1) the Mann-Whitney U Test, and (2) the outside value test. Nonparametric statistics, also called distribution-free tests, were used because they require less restrictive assumptions about the underlying distributions such as the assumption of normality and equal variance, which usually are difficult to meet, especially in small environmental samples. The statistical evaluation approach, presented as Appendix I-5, is summarized below.

The OU 1 inorganic data set was statistically compared to the background data set using the Mann-Whitney U test procedure in order to gain a better understanding of underlying value distributions and systematic differences (such as varying detection limits) between the two populations. The U test, a nonparametric analog of the better known Student's t test, determines if two samples are likely to have been drawn from a single population (at some confidence level). This procedure was used to determine whether an analyte and/or compound detected in the site samples is significantly above background so as to be considered potentially affected by site activities; otherwise, the detected analyte and/or compound was considered not site related (i.e., within ranges expected of background values).

For each sampled medium (groundwater and surface soils), the OU 1 data set was subjected to statistical analysis to determine if it represented a consistent population. This examination was performed by identifying points in need of closer scrutiny through the use of a nonparametric outside value identification method based on the definition of a "fourth spread" (Hoaglin, et al., 1983). The procedure identifies "outside values" deserving further consideration. These values are not true statistical outliers, but are distributed far enough from the sample's central value (or central tendency) to call into question their inclusion in the central population and may warrant further investigation. The resulting outside values were then evaluated to determine if there were any known factors that could explain anomalous results. A sample with several outside values would assist in identifying areas of "hot spots" or contaminated zones.

Relevant findings from the Mann-Whitney U test and outside value test for detected analytes or compounds are discussed in their respective sections below.

4.2 SOURCES OF CONTAMINATION. A full account of the known history of the facility and the land use of the area comprising OU 1 is presented in the Background Section (1.2), but the types of wastes disposed of in the landfill and burned in the firefighting training pit are discussed in more detail as potential sources of contamination below.

The types of contaminants of concern within OU 1 are polyaromatic hydrocarbons (PAHs) in the surface soil comprising the landfill cover material, and radioisotopes in the groundwater.

The types of documented wastes deposited in the landfill include film and photographic chemicals, paint thinner, garbage and trash, medical waste, yard and construction debris, and PCE stillbottoms. The petroleum products typically used by the military fire department for firefighting drills included diesel fuel and aviation fuel.

4.3 CONTAMINATION ASSESSMENT.

4.3.1 Soil Vapor Two phases of investigation were completed during site screening activities to answer questions regarding potential contamination related to landfill gas generation. These are a passive soil gas survey over the landfill and an active soil gas survey around the landfill perimeter. The results are discussed below.

4.3.1.1 **Passive Soil Gas Survey** A passive soil gas survey was completed over the landfill footprint for the purpose of

- characterizing CPCs present in the soil cover so that a proper soil gas collection system could be designed (if needed) and to allow for proper cap design;
- characterizing volatile and semivolatile constituents that have migrated to the landfill soil cover to locate potential "hot spots" that may need to be evaluated with regard to source removals to support remedial alternatives; and
- evaluating the presence of methane, which may still be problematic despite the age of the landfill.

A total of 303 passive soil gas collectors and 14 QA/QC duplicates was installed (Figure 2-6) on 50-foot centers over the landfill area, except in cases where obstructions were encountered (i.e., buildings, impenetrable soil, buried utilities). The results of the passive soil gas survey are presented in Appendix D-1. Low to very low levels of petroleum hydrocarbons are present at scattered locations across the site, but this does not suggest the presence of a significant petroleum hydrocarbon contamination problem in the shallow subsurface of OU 1. Chlorinated hydrocarbon contamination was not evident at the site.

4.3.1.2 **Active Soil Gas Survey** An active soil gas survey was conducted at OU 1, which consisted of installing and sampling soil vapor implants around the perimeter of the landfill. The objective was to evaluate the presence and potential lateral migration of methane and other landfill gases generated by landfilled materials. Landfill gas collection and treatment is an important consideration of source containment under the presumptive remedy.

Sixty active soil gas sampling implants were installed around the perimeter of the landfill (Figure 2-4). The implants were spaced at approximately 50-foot intervals, except in the northeast and southeast corners, where buildings prevented implant placement.

The results of the gas sampling at these implant locations are summarized in Appendix D-2. Sixteen samples had analytes that were detected on the field GC, but all of the detections were at very low concentrations. Methane screening was performed at each of the soil vapor implant locations, and there were no methane detections.

<u>4.3.2 **Surface Soil**</u> To assess the quality of the landfill cover, 14 surface soil samples (plus 2 duplicates) were collected for laboratory analysis. The sample locations were based on one sample per acre coverage. Positive detections in the analytical results are discussed in Paragraphs 4.3.2.1 through 4.3.2.5. Positive detection tables are provided in Appendices I-2.1 and I-2.2. The complete laboratory result summaries are provided in Appendix I-3. Interpretation of the inorganic analytical data in terms of possible sources and extent of compounds exceeding background using the statistical population comparisons is discussed in Paragraph 4.3.2.6. In order to focus the discussion on detected analytes or compounds that are site related, preliminary comparisons to Florida Department of Environmental Protection (FDEP) soil cleanup goals (SCGs) and USEPA Region III risk-based concentrations (RBCs) were made.

4.3.2.1 **Volatile Organics** Acetone was detected in 15 of 16 surface soil samples (including 2 field duplicates) at concentrations ranging from 6 to 18 micrograms per kilogram (μg/kg) (Table 4-1 and Appendix I-2.1). This compound, however, appears to be an analytical artifact, as it is highly unlikely that this compound is present in surface soils due to its high volatility and because no other related volatile organic contaminant is present (e.g., other ketones). There are no other volatile organic compound detections.

4.3.2.2 **Semivolatile Organics** PAHs were detected in surface soil samples primarily from three adjacent locations (S004, S005, and S010). Related single PAH compounds were also detected below contract-required quantitation limits (CRQLs) in samples from S002 and S003 (Table 4-1 and Appendix I-2.1). Statistical analysis of detected levels of PAH compounds in the OU 1 surface soil data indicated that the concentrations were outside values. This indicates that there is a localized occurrence of PAH contamination at these locations (Appendix I-5). The PAH contamination is believed to be site related because of the historical use of the site (the firefighter training pit) and the spatial relation between those sample locations and their proximity to the firefighter training pit. For purposes of comparison, the PAHs benzo(a)pyrene, dibenz(a,h)anthracene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene concentrations exceeded the residential RBCs or residential SCGs (Figure 4-1). However, only benzo(a)pyrene in sample S010 exceeded the industrial RBC.

Table 4-1
Summary Statistics of Detected Analytes/Compounds in Surface Soil Samples

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Parameter	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Level	Maximum Detected Level	Average Positive Detections	No. of Detects/ Total No. Samples	Background Screening Value
Inorganic Analytes (mg/kg)							
Aluminum	N/A	N/A	182	1,200	618.688	16/16	2,088
Arsenic	0.38	0.4	0.42	2.9	1.408	11/16	1.04
Barium	N/A	N/A	0.96	19.1	7.335	16/16	8.7
Cadmium	0.62	0.66	0.8	2.1	1.38	5/16	0.98
Calcium	N/A	N/A	305	119,000	30,112.875	16/16	25,295
Chromium	N/A	N/A	1.1	26.8	7.194	16/16	4.6
Copper	0.28	1.6	2.3	15.2	8.07	10/16	4.1
Iron	N/A	N/A	109	944	338.625	16/16	712
Lead	N/A	N/A	1.4	24.3	8.5	16/16	14.5
Magnesium	20.7	21.5	59.5	922	291.943	14/16	328
Manganese	N/A	N/A	1.5	11.7	6.088	16/16	8.1
Mercury	0.02	0.02	0.02	0.74	0.155	11/16	0.07
Potassium	89.3	122	105	105	105	1/16	157
Silver	0.52	3.4	3.3	6	4.267	3/16	1.8
Thallium	0.38	0.45	0.39	0.39	0.39	1/16	2
Vanadium	0.51	1.3	0.54	5.8	2.175	13/16	3.1
Zinc	N/A	N/A	2.6	60.1	22.925	16/16	17.2
Volatile Organic Compounds (µg/kg)							
Acetone	10	10	6	18	8.8	15/16	--
Semivolatile Organic Compounds (µg/kg)							
Acenaphthene	340	350	100	100	100	1/16	--
Anthracene	340	350	130	130	130	1/16	--
Benzo(a)anthracene	340	350	120	480	263.333	3/16	--
Benzo(a)pyrene	340	350	200	1,200	600	3/16	--
Benzo(b)fluoranthene	340	350	250	410	330	2/16	--

See notes at end of table.

Table 4-1 (Continued)
Summary Statistics of Detected Analytes/Compounds in Surface Soil Samples

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Parameter	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Level	Maximum Detected Level	Average Positive Detections	No. of Detects/ Total No. Samples	Background Screening Value
Semivolatile Organic Compounds (µg/kg)							
Benzo(g,h,i)perylene	340	350	120	2,500	797.5	4/16	--
Benzo(k)fluoranthene	340	350	210	4,000	1,533.333	3/16	--
bis(2-Ethylhexyl)phthalate	340	350	190	280	226.667	3/16	--
Carbazole	340	350	93	93	93	1/16	--
Chrysene	340	350	210	500	326.667	3/16	--
Dibenz(a,h)anthracene	340	350	120	760	440	2/16	--
Fluoranthene	340	350	93	1,100	450.75	4/16	--
Indeno(1,2,3-cd)pyrene	340	350	160	2,300	913.333	3/16	--
Phenanthrene	340	350	150	620	385	2/16	--
Pyrene	340	350	160	1,000	530	3/16	--
Pesticides/PCBs (µg/kg)							
4,4'-DDD	3.4	18	3.5	3.5	3.5	1/16	--
4,4'-DDE	3.4	3.5	1.8	43	15.444	9/16	--
4,4'-DDT	3.4	3.5	2	48	15.929	7/16	--
alpha-Chlordane	1.7	1.8	1.1	85	26.592	12/16	--
gamma-Chlordane	1.7	1.8	1	53	18.682	11/16	--
Dieldrin	3.4	3.5	3.8	180	70.863	8/16	--
gamma-BHC (Lindane)	1.7	9.2	1.2	1.2	1.2	1/16	--
Heptachlor epoxide	1.7	1.8	4.3	7.2	6.175	4/16	--
Aroclor-1260	34	35	35	150	83.143	7/16	--
Total Petroleum Hydrocarbons (mg/kg)	N/A	N/A	10.1	96.6	35.944	16/16	--

Notes: N/A = not applicable.
µg/kg = micrograms per kilogram.
-- = analyzed for but not detected.
PCBs = polychlorinated biphenyls.
DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram.
BHC = benzene hexachloride.

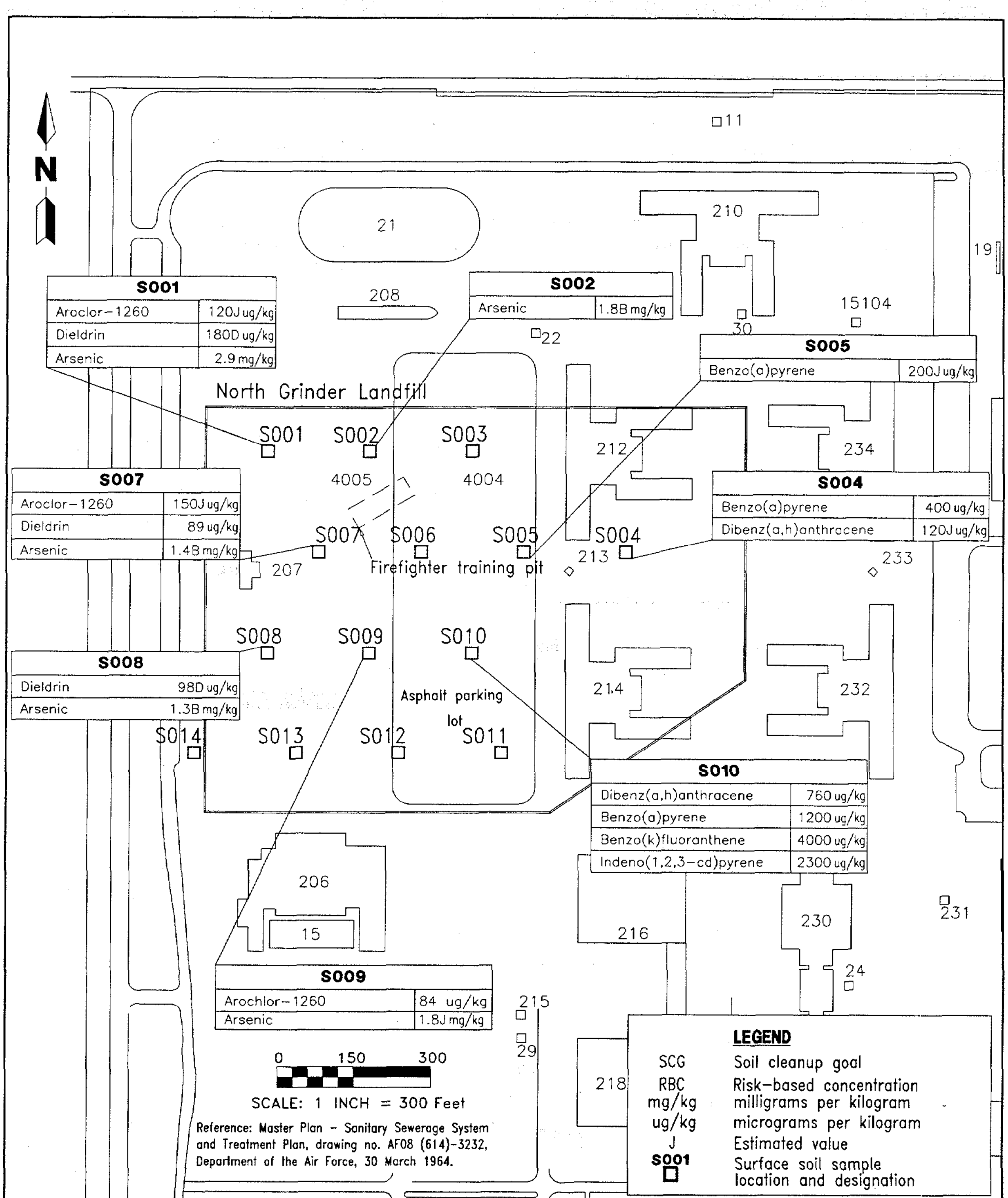

FIGURE 4-1
LOCATION OF DETECTED COMPOUNDS IN SURFACE SOIL EXCEEDING THE HIGHER OF BACKGROUND, RESIDENTIAL SCGs OR RBCs

REMEDIAL INVESTIGATION OPERABLE UNIT 1

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4.3.2.3 **Pesticides and PCBs** Several pesticide compounds were detected primarily at low levels in 12 of 16 surface soil samples (Table 4-1 and Appendix I-2.1). They include 4,4-dichlorodiphenyltrichloroethane (DDT) and its degradation products (4,4-dichlorodiphenyldichloroethane [DDD] and 4,4-dichlorodiphenyldichloroethene [DDE]), alpha-chlordane and gamma-chlordane, dieldrin, gamma-benzene hexachloride (BHC) (Lindane), and heptachlor epoxide. Only Dieldrin concentrations exceeded both the residential SCG and residential RBC at three sample locations (S001, S007, and S008).

A PCB compound, Aroclor-1260, was also detected in seven samples from six locations (S001, S002, S007, S008, S009, and S013) at concentrations ranging from 35 to 150 $\mu g/kg$. Statistically, five of seven Aroclor-1260 detections were identified as outside values, indicating site-related contamination. Aroclor-1260 concentrations exceeded the residential RBC at three sample locations (S001, S007, and S009).

4.3.2.4 **Herbicides** There were no herbicides detected in surface soil samples.

4.3.2.5 **Inorganics** One or more inorganics were detected above background levels in 13 of 16 surface soil samples, all of which are expected to be present naturally in the soil (Table 4-1 and Appendix I-2.2). Of the detected inorganics, arsenic, calcium, chromium, copper, magnesium, and zinc are statistically higher in OU 1 than the background data set, indicating that they are site related (Table 4-2). Cadmium, silver, potassium, and thallium were also found to be from different populations, but because many of the samples are below detection limits, these differences mostly reflect the variation in the reported detection limits between the two groups. It appears, however, that only cadmium and silver are site related because the outside values exceed the highest background detection. For purposes of comparison, only arsenic concentrations at eight sample locations (and one duplicate) exceed the residential RBC (carcinogenic) and the residential SCG.

4.3.2.6 **Interpretation of Surface Soil Data** Contaminants detected in surface soil samples collected in the landfill cover material primarily included pesticides and a PCB compound, inorganics, and PAHs. Statistically, all these contaminants are site related, occurring as outside values. Some inorganics (arsenic, calcium, chromium, copper, magnesium, and zinc) are statistically different from the background population.

Pesticide detections at low parts per billion (ppb) concentrations appear to indicate a systematic use of pesticides on the parade field because of its land use. PCB detections at low ppb concentrations were detected in surface soil samples collected across the grass-covered parade field, but not under the asphalt-covered portion. This suggests that oil with PCB concentrations may have been applied to the parade field following construction of the parking lot after the asphalt was laid, possibly as a means of controlling dust.

Some inorganics detected above background that statistically appear to be site related are probably connected to the systematic use of pesticides and fertilizers on the parade field (especially arsenic). Some inorganics (barium, cadmium, calcium, chromium, copper, mercury, and zinc) are significantly above background concentrations in enough samples to indicate that the soil is from a different source (fill material).

Table 4-2
Summary of Population Comparisons on OU 1 Versus Background Surface Soil Analytical Results

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Parameter	Population statistical summary
Arsenic	OU 1 population higher
Calcium	OU 1 population higher
Chromium	OU 1 population higher
Copper	OU 1 population higher
Magnesium	OU 1 population higher
Zinc	OU 1 population higher
Cadmium	Different populations but comparison largely driven by detection limit differences; OU 1 data set have four detections exceeding the background range; considered site-related.
Silver	Different populations but comparison largely driven by detection limit differences; OU 1 data set have three detections exceeding background range; considered site-related.
Potassium	Different populations but comparison largely driven by detection limit differences; OU 1 data set have only one detection; not considered site-related.
Thallium	Different populations but comparison largely driven by detection limit differences; OU 1 data set have one detection within the range of background; not considered site related.

Notes: See Appendix I-5 for details on these population comparisons. "Detection limit differences" means that numerous data points in both data sets are below detection limits and therefore the population differences may be attributed primarily to the differences in detection limits and not the few actual detections. Acetone was found to be significantly higher in the background data set because most OU 1 detections are below Contract Required Quantitation Limits; however this compound is considered a field and/or laboratory artifact. Aluminum was also found to be significantly higher in the background data set.

OU = operable unit.

It is not unusual to find detectable levels of PAHs in urban surface soil environments, mainly originating from high temperature combustion sources such as automobile exhausts, urban fires, and boilers. However, the sample locations where PAHs were detected are grouped together as opposed to being randomly scattered throughout OU 1. The fact that three locations are in close proximity to the east side of the old firefighting training pit, and two locations are to the north of the pit, suggests a relationship (S004, S005, and S010, and S002 and S003, respectively; see Figure 4-1). The PAH contamination may be derived from either windblown ash from burning flammable materials in the fire pit (the prevailing winds are westerly and southerly) or from earth moving during the development of the parade field, which may have spread the remnant of contaminated soil away from the pit. The lighter volatile organics associated with petroleum products used by the military fire department, such as BTEX or naphthalenes, were not detected.

Another potential source of PAHs considered was from leaching of the asphalt pavement above two of the sample locations. However, samples were collected beneath asphalt at four other locations where no PAHs were detected, and there is no asphalt at sample locations S002, S003, or S004. The asphalt pavement, acting as an impermeable cap, has more likely contributed to the prevention of both manmade or vegetative disturbances of the topsoil, and leaching of contaminants by surface water infiltration.

<u>4.3.3 Groundwater</u> The groundwater was initially screened using DPT and a field GC to strategically place the monitoring well clusters. A total of 151 groundwater samples was collected from depths ranging from 6 to 70 feet bls (Appendix B). Ten of these samples were sent to an offsite laboratory for confirmation of the GC results with CLP methodology. Appendix B provides a summary of the groundwater screening studies by DPT, along with the field GC and confirmation laboratory results. Based on the groundwater screening results, nine monitoring well clusters (27 wells) were initially installed and sampled for laboratory analysis. Based on these analyses, another well cluster (two wells) was installed farther upgradient from the landfill. Positive detections in the analytical results for 32 unfiltered (and 32 filtered) groundwater samples, including 3 field duplicates, are discussed in Paragraphs 4.3.3.1 through 4.3.3.7, and positive detection tables are provided in Appendices I-2.3 through I-2.5. The complete laboratory results are provided in Appendix I-3. Interpretation of the groundwater analytical data in terms of possible sources and extent of compounds exceeding background and/or MCLs is discussed in Paragraph 4.3.3.8.

4.3.3.1 **Volatile Organics** During groundwater field screening by DPT (Appendix B), 148 samples were analyzed by a portable GC for VOCs, which included benzene, toluene, ethylbenzene, m-xylene, o-xylene, TCE, PCE, and DCA. With the exception of nine locations, most of the detected VOCs were below the Florida Primary Drinking Water Standard (FPDWS). The detected contaminants with concentrations at or exceeding FPDWSs were limited to benzene at five locations, two on the south side of the landfill (9.7 micrograms per liter [$\mu g/\ell$] at U1P01902 and 7.5 $\mu g/\ell$ at U1P05002) and three on the northeast side (1.2 $\mu g/\ell$ at U1P03702, 3.7 $\mu g/\ell$ at U1P03901, and 2.7 $\mu g/\ell$ at U1P05702), and tetrachloroethylene (PCE) at four locations along the west and northwest sides (5.2 $\mu g/\ell$ at U1P00202, 5.0 $\mu g/\ell$ at U1P00302, 7.3 $\mu g/\ell$ at U1P00401, and 3.3 $\mu g/\ell$ at U1P00603). Ten samples were submitted to a laboratory for analysis. No detections of benzene or PCE were reported in any of the samples submitted for confirmation.

The groundwater screening results indicated two zones of minor VOC contamination (Figure 6 of Appendix B). BTEX (26.5 $\mu g/\ell$) was detected in sample U101902, which was collected near an underground storage tank (UST) at Building 206. This UST was subsequently closed and found to be clean; therefore, a probable source for the detected petroleum constituents is a surface spill from a fuel truck. The analytical results from the groundwater screening survey (field GC and laboratory) are included in Appendix B.

VOCs detected by laboratory analyses of groundwater samples collected from the installed monitoring wells include acetone, carbon disulfide, and chlorobenzene (Table 4-3). Acetone appears to be a sampling and/or analytical artifact as there is no reason to believe it is present without the presence of similar compounds (e.g., other ketones). Carbon disulfide is only present in one sample from a deep well (OLD-U1-27C). BTEX constituents and PCE were not detected in any of the groundwater samples. Detected VOCs do not exceed their respective FDEP groundwater guidance values or tap water RBCs (Appendix I-2.3).

4.3.3.2 **Semivolatile Organics** Semivolatile organic compounds detected in groundwater include 1,4-dichlorobenzene, bis(2-ethylhexyl)phthalate, dimethyl-phthalate, naphthalene, and phenol (Table 4-3). Concentrations of all these compounds, except bis(2-ethylhexyl)phthalate, do not exceed FDEP guidelines or tap water RBCs. The exception is considered a common laboratory artifact.

4.3.3.3 **Pesticides and PCBs** One pesticide compound, 4,4-DDT, was detected at 0.06 $\mu g/\ell$ in one shallow groundwater well (OLD-U1-25A). This detection does not exceed its FDEP guideline or tap water RBC (0.2 $\mu g/\ell$).

4.3.3.4 **Herbicides** One herbicide compound, 2,4-D was detected at 3.4 $\mu g/\ell$ in one shallow groundwater well (OLD-U1-01A). This detection does not exceed the FDEP guidelines (MCL) or tap water RBC (61 $\mu g/\ell$).

4.3.3.5 **Inorganics** One or more inorganics were detected in 16 of 32 unfiltered groundwater samples at concentrations above background screening levels (Table 4-3 and Appendix I-2.4). The samples with the higher number of exceedances (3 to 12 inorganics) came from intermediate and deep wells (OLD-U1-03C, -06C, -15C, -17B, -26B, -27C, -28B, and -29C). As there is a noticeable increase in certain inorganics with depth in the surficial aquifer, a comparison between OU 1 and background data may not be useful, as the background data set includes only shallow monitoring wells. Nevertheless, statistical analysis of OU 1 groundwater inorganic data and the background data set indicate no population differences for most inorganics, except for cadmium, potassium, selenium, and vanadium. Cadmium and selenium, however, are not considered site related (Table 4-4). The difference in potassium populations can be accounted for by grout intrusion in deep well OLD-U1-27C, the sample which exhibited the only outside value. Initial purged water from this well has also consistently tested high in pH (ranging from 8.98 to 11.34).

Most of the inorganic concentrations above background levels are below FDEP groundwater guidance concentrations or Florida's Primary or Secondary drinking water standards (FPDWS or FSDWS). Exceptions were beryllium, vanadium, and

Table 4-3
Summary Statistics of Detected Analytes and Compounds in Groundwater Samples

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Parameter	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Level	Maximum Detected Level	Average Positive Detections	No of/ Total No. Samples	Background
Unfiltered Groundwater							
Inorganic Analytes ($\mu g/\ell$)							
Aluminum	24.7	24.7	62.4	101000	6629	30/32	4067
Arsenic	1.5	14.8	3.3	14	7.3	3/32	5
Barium	0.5	6.1	3.6	870	94.1	29/32	31.4
Beryllium	0.2	4	0.21	7.1	2.4	6/32	
Cadmium	2.4	5	4.2	4.2	4.2	1/32	5.6
Calcium	15.7	15.7	1860	128000	17485	30/32	36,830
Chromium	2	13	2.5	121	26.7	10/32	7.8
Copper	1.4	5	1.4	29.6	4.78	14/32	5.4
Iron	6.1	6.1	9.4	8030	1555	28/32	1227
Lead	1.3	3.2	1.5	91.8	16.3	7/32	4
Magnesium	28	28	428	4550	1961	30/32	4560
Manganese	0.5	2.1	0.86	116	17.5	28/32	17
Mercury	0.04	0.15	0.04	0.6	0.14	6/32	0.12
Potassium	403	403	444	28100	4096	31/32	5400
Selenium	0.6	2.5	0.9	19	4.5	7/32	9.7
Sodium	220	231	1550	46700	12575	30/32	18222
Vanadium	2.9	2.9	3.7	104	21.3	15/32	20.6
Zinc	1.2	5.2	1.2	42.6	8.7	18/32	4
Volatile Organic Compounds ($\mu g/\ell$)							
1,4-Dichlorobenzene	10	10	1	8	2.4	5/30	N/A
Acetone	10	15	4	46	22.667	3/30	N/A
Carbon disulfide	10	10	4	7	5.5	2/30	N/A
Chlorobenzene	10	10	4	5	4.333	3/30	N/A
Semivolatile Organic Compounds ($\mu g/\ell$)							
bis(2-Ethylhexyl)phthalate	10	10	2	30	7.667	6/30	N/A
Dimethylphthalate	10	10	7	7	7	1/30	N/A
Naphthalene	10	10	3	3	3	1/30	N/A
Phenol	10	10	1	1	1	1/30	N/A
Pesticides ($\mu g/\ell$)							
(2,4-Dichlorophenoxy)acetic acid	2.5	2.5	3.4	3.4	3.4	1/30	N/A
4,4'-DDT	0.1	0.1	0.055	0.055	0.055	1/30	N/A

See notes at end of table.

Table 4-3 (Continued)
Summary Statistics of Detected Analytes and Compounds in Groundwater Samples

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Parameter	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Level	Maximum Detected Level	Average Positive Detections	No. of Detects/ Total No. Samples	Background
Unfiltered Groundwater (Cont.)							
Radiological (pCi/ℓ)							
Gross Alpha	1	1	1.6	257	23.08	32/36	13
Gross Beta	3	3	3.4	240	29.87	35/36	9.5
Cesium-137	N/A	N/A	-0.972	0.038	-0.43	4/4	NA
Lead-210	N/A	N/A	1.21	1.21	1.21	1/1	NA
Polonium-210	N/A	N/A	0.13	0.13	0.13	1/1	NA
Potassium-40	N/A	N/A	5.88	28.4	15.10	5/5	NA
Radium-226	N/A	N/A	0	8.83	3.69	5/5	NA
Radium-228	N/A	N/A	0	1.81	0.89	4/4	NA
Thorium-227	N/A	N/A	0.041	0.446	0.16	4/4	NA
Thorium-228	N/A	N/A	0.23	4.55	1.60	5/5	NA
Thorium-230	N/A	N/A	1.74	3.43	2.44	5/5	NA
Thorium-232	N/A	N/A	0.086	0.386	0.23	4/4	NA
Uranium-234	N/A	N/A	1.48	7.74	5.12	5/5	NA
Uranium-238	N/A	N/A	0.956	8.72	5.46	5/5	NA
General Chemistry (mg/ℓ)							
Alkalinity	1	1	2	152	36.5	10/11	NA
Hardness	N/A	N/A	11	108	42	12/12	NA
Nitrate	0.02	0.02	0.04	1.6	0.614	8/12	NA
Nitrate/Nitrite	0.02	0.02	0.04	1.6	0.597	7/11	NA
pH (units)	N/A	N/A	4.5	9.65	6.213	12/12	NA
Sulfate	N/A	N/A	2.2	35.2	18.342	12/12	NA
Sulfide	0.5	0.5	0.5	4.3	1.833	6/12	NA
Total Dissolved Solids	N/A	N/A	66	876	252.5	16/16	NA
Total Suspended Solids	1	1	1	900	154.167	6/12	NA
Total Phosphorus	0.01	0.01	0.18	15	3.63	9/12	NA
Total Organic Carbon	N/A	N/A	1.3	26.1	9.8	12/12	NA
Total Petroleum Hydrocarbons	1	1	2.6	3.5	2.933	3/41	NA

See notes at end of table.

Table 4-3 (Continued)
Summary Statistics of Detected Analytes and Compounds in Groundwater Samples

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Parameter	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Level	Maximum Detected Level	Average Positive Detections	No. of Detects/ Total No. Samples	Background
Filtered Groundwater							
Inorganic Analytes ($\mu g/\ell$)							
Aluminum	24.7	24.7	32.6	11500	1371	31/32	NA
Arsenic	1.5	14.8	2.9	14.5	7	3/32	NA
Barium	0.5	3.4	4.6	353	43.88	30/32	NA
Beryllium	0.2	4	1.1	5	2.3	4/32	NA
Calcium	15.7	15.7	318	94700	13311	31/32	NA
Chromium	2	10	2.1	19.4	5.43	6/32	NA
Cobalt	3	10	3.1	3.9	3.5	2/32	NA
Copper	1.4	5	1.4	6.4	2.4	10/32	NA
Iron	6.1	6.1	31.2	2820	723	25/32	NA
Lead	1.3	1.3	1.8	6.1	3.44	5/32	NA
Magnesium	28	28	120	4050	1605	31/32	NA
Manganese	0.5	0.5	0.86	82	10.32	30/32	NA
Mercury	0.04	0.11	0.04	0.06	0.05	4/32	NA
Nickel	11.2	15	11.4	11.4	11.4	1/32	NA
Potassium	403	403	540	18200	3166	30/32	NA
Selenium	0.6	2.5	1	3.9	2.4	4/16	NA
Silver	2.4	5	2.7	2.8	2.77	3/32	NA
Sodium	214	214	1470	38200	11150	31/32	NA
Thallium	1.9	18.7	1.9	4.6	2.95	6/32	NA
Vanadium	2.9	10	3.1	50.2	11.64	13/32	NA
Zinc	1.2	11.3	1.5	54.7	9.39	21/32	NA
Radiological (pCi/ℓ)							
Gross Alpha	N/A	N/A	3.75	33.9	20.62	6/6	NA
Gross Beta	N/A	N/A	6.67	86.8	28.21	6/6	NA
Cesium-137	N/A	N/A	-1.29	0.264	-0.83	4/4	NA
Potassium-40	N/A	N/A	-109	65.2	13.63	4/4	NA
Radium-226	N/A	N/A	0	4.61	3.14	4/4	NA
Radium-228	N/A	N/A	0	2.03	1.08	4/4	NA
Thorium-227	N/A	N/A	0.036	0.504	0.17	4/4	NA
Thorium-228	N/A	N/A	1.14	4.82	2.08	4/4	NA

See notes at end of table.

Table 4-3 (Continued)
Summary Statistics of Detected Analytes and Compounds in Groundwater Samples

Remedial Investigation Report, Operable Unit 1
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Naval Training Center
Orlando, Florida

Parameter	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Level	Maximum Detected Level	Average Positive Detections	No. of Detects/ Total No. Samples	Background
Filtered Groundwater (Cont.)							
Radiological (pCi/ℓ)							
Thorium-230	N/A	N/A	2.35	4.5	3.20	4/4	NA
Thorium-232	N/A	N/A	0.081	0.291	0.23	4/4	NA
Uranium-234	N/A	N/A	1.34	9.08	5.85	4/4	NA
Uranium-238	N/A	N/A	1.23	9	5.67	4/4	NA

Notes: min. = minimum.
max. = maximum.
μg/ℓ = micrograms per liter.
-- = analyzed for but not detected.
N/A = not applicable.
DDT = dichlorodiphenyltrichloroethane.
pCi/ℓ = picocuries per liter.
mg/ℓ = milligrams per liter.
NA = not analyzed.

Table 4-4
Summary of Population Comparisons on OU 1 Versus Background Groundwater Analytical Results

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Parameter	Population statistical summary
Antimony	Different populations but comparison is due to detection limit differences.
Barium	OU 1 population significantly higher.
Cadmium	Different populations but comparison largely driven by detection limit differences. There is only one detection in both data sets.
Potassium	OU 1 population significantly higher.
Selenium	Different populations but comparison largely driven by detection limit differences; one detection in the OU 1 population exceeds the maximum detection in the background population.
Thallium	Different populations but comparison is due to detection limit differences.
Gross beta	OU 1 population significantly higher than background and FDEP's St. Johns Water Management District shallow aquifer database.

See Appendix I-5 for details on these population comparisons. "Detection limit differences" means that numerous data points in both data sets are below detection limits and, therefore, the population differences may be attributed primarily to the differences in detection limits and not the few actual detections.

OU 1 sample data set for volatile organics included Level III data from direct push technology sampling program confirmatory samples.

Notes: OU = Operable Unit.
FDEP = Florida Department of Environmental Protection.

manganese, which were detected at 7.1 μg/ℓ, 104 μg/ℓ, and 116 μg/ℓ, respectively, in a sample from a deep well (OLD-U1-03C), and thallium at 4.6 μg/ℓ in a sample from an intermediate well (OLD-U1-08B). The FDEP guidance concentration for vanadium is 49 μg/ℓ. The FPDWS for beryllium and thallium is 4 μg/ℓ and 2 μg/ℓ, respectively, and the FSDWS for manganese is 50 μg/ℓ. Background values for aluminum and iron, which were exceeded by one or both inorganics in samples from wells OLD-U1-03C, -06C, -17B, -23B, -26B, and -27C, are higher than FSDWSs (Figure 4-2). Groundwater samples from the new upgradient wells, OLD-U1-28B and -29C, also had elevated aluminum and iron, but the sample from OLD-U1-28B also had elevated chromium (121 μg/ℓ), lead (91.8 μg/ℓ), manganese (93.3 μg/ℓ), and vanadium (81.1 μg/ℓ). As will be discussed in Paragraph 4.3.3.8, there appears to be a relationship between certain inorganics (especially vanadium) detected in OU 1 groundwater samples and elevated radiological parameters.

4.3.3.6 **Radiological Parameters** Elevated gross alpha (above MCL of 15 picocuries per liter [pCi/ℓ]) was initially detected in groundwater samples from four monitoring wells: deep well OLD-U1-03C, intermediate well OLD-U1-14B, intermediate well OLD-U1-26B, and deep well OLD-U1-27C (Table 4-3 and Figure 4-2). The background screening concentration for gross alpha is 13.0 pCi/ℓ. Detected gross alpha in the sample from deep well OLD-U1-06C exceeded the background concentration, but not the MCL. Elevated gross beta (above background level of 9.5 pCi/ℓ) was also detected in these same five samples, and in samples from deep wells OLD-U1-12C and -15C, and shallow well OLD-U1-07A. Gross beta was 10 times greater than background at well OLD-U1-14B (102 pCi/ℓ). These elevated levels were confirmed in four wells by resampling and analysis, which included specific radionuclides to establish major alpha and beta emitters. The specific radionuclides contributing to the elevated radioactivity in OU 1 groundwater are discussed in Paragraph 4.3.3.8 below.

Background concentrations for both gross alpha and beta are from shallow wells only and do not represent background concentrations in the basal zone of the surficial aquifer. Therefore, an additional set of background monitoring wells screened in the intermediate and deep zones of the surficial aquifer (OLD-U1-28B and -29C, respectively) were installed farther upgradient of the landfill. The groundwater in this area is very turbid, even during slow purging. Filtering the groundwater samples with a 0.2 micron filter was required to obtain less than 5 NTUs. The unfiltered samples were also above background for gross alpha (44.2 and 22.9 pCi/ℓ, respectively) and gross beta (31.7 and 32.1 pCi/ℓ, respectively). Filtering reduced the gross alpha radioactivity to 4.49 and 3.75 pCi/ℓ, respectively, and the gross beta radioactivity to 6.67 and 10.7 pCi/ℓ, respectively. As will be discussed in Paragraph 4.3.3.8, there is a high correlation between turbidity and radiological parameters.

4.3.3.7 **Bacteriological Indicators** Nine wells were resampled for parameters indicative of anaerobic microbial activity to test the hypothesis that this activity is causing mobilization of naturally occurring radionuclides (Table 4-5). Two well clusters, one upgradient (OLD-U1-01A, -02B, and -03C) and one downgradient (OLD-U1-13A, -14B, and -15C), each with an intermediate or deep well screened in groundwater having elevated gross alpha and beta, were included to identify differences in the aquifer with depth. The remaining three wells (OLD-U1-06C, -26B, and -27C), located along the landfill perimeter, are also screened in groundwater with elevated gross alpha and beta. Four analyses (pH,

Table 4-5
General Parameters as Bacteriological Indicators in Groundwater

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Parameters	Shallow		Intermediate			Deep			
	OLD-U1-01A	OLD-U1-13A	OLD-U1-02B	OLD-U1-14B	OLD-U1-26B	OLD-U1-03C	OLD-U1-06C	OLD-U1-15C	OLD-U1-27C
pH, units	5.44	5.20	4.44	5.10	5.95	5.53	4.99	5.02	6.25
Cond, μmho/cm	155	102	60	151	110	61	150	160	120
Eh, mV	190.3	310.9	101.3	62.7	-39.4	92.9	121.1	-3.2	-30.2
DO, mg/ℓ	5.1	3.0	4.3	3.3	1.5	5.2	2.2	2.0	1.2
CH_4, mg/ℓ	NA	NA	NA	0.116	NA	0.025	NA	NA	0.079
TSS, mg/ℓ	NA	NA	NA	3	NA	52.5	NA	NA	101.1
%VSS	NA	NA	NA	33	NA	84	NA	NA	78
TDS, mg/ℓ	NA	NA	NA	NA	92	NA	NA	NA	876
Total P, mg/ℓ	NA	NA	NA	NA	3.6	NA	NA	NA	15
Gross alpha, pCi/ℓ	2.0	<1.0	8.7	37.8	31.2	50.4	14.5	11.6	53
Gross beta, pCi/ℓ	4.8	3.9	7.4	102	28.6	58.5	25.8	44.9	57

Monitoring wells OLD-U1-01A, -02B, -03C are one cluster.
Monitoring wells OLD-U1-13A, -14B, -15C are one cluster.
TDS and total P values for OLD-U1-26B and -27C are from the 8/95 sampling event.
Gross alpha and beta values are from the 10/95 sampling event.
Reported concentrations expressed in the following units as indicated: μmhos/cm = micromhos per centimeter, mV = millivolts, and mg/ℓ = milligram per liter.

Notes: Cond. = electrical conductivity.
μmho/cm = micromhos per centimeter.
Eh = redox potential.
mV = millivolts.
DO = dissolved oxygen.
mg/ℓ = milligrams per liter.
CH_4 = methane gas.
NA = not analyzed.
TSS = total suspended solids.
% = percent.
VSS = volatile suspended solids.
TDS = total dissolved solids.
P = phosphorus.
pCi/ℓ = picocuries per liter.

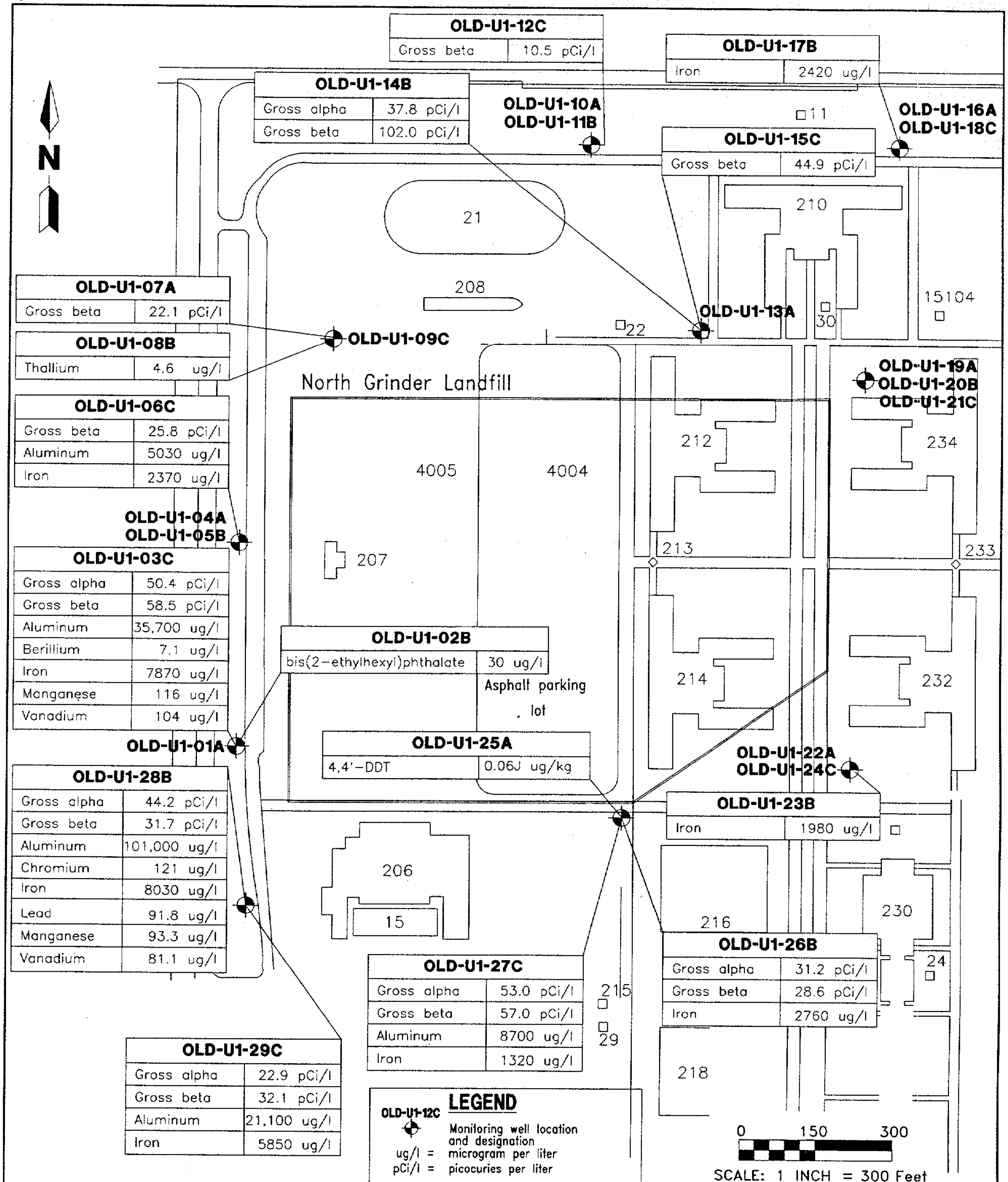

FIGURE 4-2
LOCATION OF ANALYTES IN GROUNDWATER EXCEEDING BACKGROUND OR MAXIMUM CONTAMINANT LEVELS

REMEDIAL INVESTIGATION OPERABLE UNIT 1

NAVAL TRAINING CENTER ORLANDO, FLORIDA

NTC-OU1.RIR GRINDER\NGACHEM\NAB\12-19-96
PMW.12.96

conductivity, Eh, and DO) were performed in the field at all nine wells. Samples for methane (CH_4), TSS, and VSS analysis were only collected from the three wells from which previous samples had the highest gross alpha and beta activity (OLD-U1-03C, -14B, and -27C). The analytical results are summarized in Table 4-5, which includes the previous gross alpha and beta, TDS, and total phosphorus results for comparison.

4.3.3.8 **Interpretation of Groundwater Data** Contaminants detected in the groundwater that exceed background and/or regulatory standards consisted of gross radioactivity and some inorganics. Relative to analytical results of samples from both background and downgradient monitoring wells, gross alpha and gross beta are elevated in the groundwater in the immediate vicinity of the landfill, at depths that are within the Hawthorn Group phosphatic sands above the upper clay layer (OLD-U1-03C, -6C, -14B, -15C, -26B, and -27C). Elevated gross alpha was not detected in samples from any shallow wells, nor from any wells downgradient and outside the immediate vicinity of the landfill. The same is true for gross beta except for one shallow well, OLD-U1-07A.

Monitoring wells screened in groundwater with elevated gross alpha and beta were resampled for specific radionuclides to identify radioactive constituents. Specific radionuclides selected for analysis were based on most probable sources (radium paint and natural sources), and included major contributors in the uranium-238 series, potassium-40 and cesium-137.

Of the radionuclides analyzed, the major contributors to gross alpha include uranium-238 and -234, thorium-230, and radium-226. These alpha emitters accounted for 25 to 55 percent of gross alpha. There may also be some contribution from radon-222 and polonium-210, which are also in the uranium-238 series, but were not analyzed.

The major contributors to gross beta include potassium-40 and radium-228. These beta emitters only accounted for 13 to 17 percent of gross beta, except in one sample, where they accounted for 99 percent. The potassium-40 values are suspect because there is a high uncertainty associated with a gamma scan analysis of this radioisotope. Therefore, potassium-40 may be contributing more to gross beta than is indicated. There also appears to be some contribution from uranium-238 daughters not scanned, such as thorium-234, lead-214, bismuth-214, and lead-210. These daughters were observed in the gamma spectra raw data, but were not quantified. The beta emission from the alpha emitters was also not taken into account.

<u>Potential Sources</u>. Because OU 1 is a military landfill, and all wastes deposited in the landfill may not be documented, several potential radioactive sources must be considered. The hypothesis must not only explain the source of the radionuclides detected, but must also provide reasonable clues as to what radionuclides are contributing most of the gross alpha and beta activity not accounted for. Possible sources include radium paint, medical wastes, and/or nuclear research wastes deposited in the landfill, upgradient contamination, and mobilization of naturally occurring radionuclides associated with the phosphates in the Hawthorn Group deposits. Medical waste is the only documented waste in the landfill with potential radioactivity. The radionuclides associated with each source are given in Table 4-6.

Table 4-6
Expected Radionuclides for Different Sources

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Source	Radionuclides	
	Major Alpha Emitters	Major Beta Emitters
Naturally Occurring	uranium series: uranium-238, -234, thorium-230, radium-226, radon-222, polonium-210 thorium series: thorium-232, -228, radium-224	uranium series: thorium-234, lead-214, bismuth-214, lead-210, bismuth-210 thorium series: radium-228, lead-212 non-series: potassium-40, vanadium-50, rubidium-87, lanthanum-138
Radium Paint	radium-226	
Medical	none	mercury-203, gold-198, iodine-131, sulfur-35, phosphorus-32
Nuclear Research	plutonium-239, uranium-235	cesium-137, cesium-134, strontium-90, tritium

The radioisotope in radium paint is predominantly radium-226, an alpha emitter. The half-life of radium-226 is approximately 1,600 years, yet it is not the parent to all the radionuclides detected, as would be expected if radium paint were the source. In the presence of the uranium isotopes, radium-226 can be explained by uranium-238 decay. As was noted previously, there were four monitoring wells (OLD-U1-03C, -014B, -026B, and -027C) with elevated gross alpha activity. For two of the four samples with elevated gross alpha (UIG02603 and UIG02703), the radium-226 concentration was less than half of uranium-238. Another sample only slightly exceeded uranium-238 (UIG00303). Radium-226 was not detected in the fourth sample (UIG01403).

The predominant radioisotopes used in medical research and treatment include phosphorus-32, sulfur-35, iodine-131, gold-198, and mercury-203, all of which have half-lives measured in days. Because these radioisotopes are not produced by radioactive decay of parent radioisotopes with long half-lives, even if they were constituents of medical waste deposited in the landfill, they would have decayed to their stable forms long ago.

Radionuclides from nuclear research, such as plutonium-239, uranium-235, strontium-90, or tritium, were not considered likely contributors to gross alpha and beta because there was no historic evidence that nuclear research was ever conducted at this installation. However, the groundwater was analyzed for cesium-137 (30.17-year half-life), a daughter product from nuclear waste, and it was not detected.

The hypothesis that the radionuclides detected in the basal zone of the surficial aquifer originate from radioactive material buried in the landfill is contradicted by the lack of elevated gross alpha and beta at the top of the surficial aquifer, especially downgradient of the landfill. The one exception to this occurs at shallow monitoring well OLD-U1-07A, where gross beta alone is approximately double the background screening value (22.1 pCi/ℓ vs. 9.5 pCi/ℓ). However, this well is sidegradient of the landfill, and gross beta is not elevated in the intermediate well of the same cluster.

The absence of elevated gross alpha and beta in the intermediate and deep zones of the shallow aquifer sidegradient of the landfill (at monitoring wells OLD-U1-08B, -09C, -23B, and -24C) and farther downgradient (at monitoring wells OLD-U1-11B, -12C, -17B, -18C, -20B, and -21C) from the landfill reduces the likelihood of an upgradient source. It is not probable that the leading edge of a plume that originated upgradient occurs only at the fringes of the landfill.

There is significant evidence, however, that supports the hypothesis that naturally occurring radionuclides associated with phosphates of the Hawthorn Group are being mobilized by anaerobic microbial activity at that depth. Of the radionuclides scanned, the significant contributions are from members of the naturally occurring uranium-238 series and potassium-40, which suggests that the remaining contributors are likely naturally occurring radionuclides as well.

Probable Source. The analytical data indicated a trend, such that the samples with high gross alpha and beta also showed increases in physical parameters such as pH, alkalinity, turbidity, TDS, and total organic carbon (TOC), and in inorganics such as aluminum, barium, beryllium, chromium, vanadium, and phosphorus (discussed below). This correlation cannot be explained by a cause and effect relationship, but can be explained by a third agent causing all these parameters to increase together.

Uranium is an important trace constituent in marine phosphorite deposits. It co-precipitates with fluorapatite ($Ca_5F[PO_4]$, the predominant mineral) in a reducing environment. Uranium is incorporated both within the crystal lattice of the phosphate mineral and as a sorbed or chemically complexed phase on clay minerals and organics (Upchurch, et al., 1991). Both radium and thorium in the Hawthorn phosphates most likely originate from radioactive decay of uranium-238. Radium forms strong bonds with sulfate and carbonate, and co-precipitates with barium sulfate (Upchurch, et al., 1991). Radium can substitute for calcium in calcium carbonates. Thorium is rare in marine sediments, but does occur in monazite, a rare earth phosphate. Radium-228 is a decay product in the thorium-232 series. The highest total gross alpha and beta activity was detected in the sample from monitoring well OLD-U1-14B, which is screened through a 2-foot zone observed to have thin phosphorite sand layers (greater than 50 percent phosphate grains).

Leachate generated from landfilled material is known to naturally increase the bacterial activity and density in the groundwater underneath a landfill. At OU 1, there is a significant downward hydraulic head differential between the upper and lower zones of the surficial aquifer along the upgradient (west and south) sides of the landfill. This steeply downward-moving groundwater under the landfill has probably caused organic compounds to be carried down to the bottom of the surficial aquifer, supplying degradable organics to the indigenous bacteria at that depth. The higher total organic carbon (TOC) at depth indicates an increase in available carbon. This supply of nutrients would cause the bacteria density to increase, and the oxidation and/or reduction condition would decrease due to their respiratory process. Under the reducing conditions created by the microorganisms, uranium, radium, and potassium minerals in the upper "leached zone" of the Hawthorn Group deposits (phosphates, sulfates, and micas, respectively) may be reduced, releasing cations and radioisotopes into solution. As carbon dioxide (CO^2) and, under increasingly reduced conditions, CH_4 are produced by metabolically active microorganisms, pH and alkalinity increase. The presence of CH_4 indicates the presence of anaerobic bacteria. Downgradient of the landfill, where the leachate is diluted and there is less available carbon, the microbial activity would be minimal, the environment would be more oxidizing, and, as a result, the concentrations of radionuclides are consistent with background levels.

This hypothesis was tested by resampling selected monitoring wells for parameters that would indicate anaerobic microbial activity in the basal zone of the surficial aquifer (pH, Eh, DO, CH_4, and percent VSS). The data supports a general trend of Eh and DO decreasing with depth, especially where gross alpha and beta are elevated (OLD-U1-26B and -27C). The Eh and DO at deep well OLD-U1-03C do not correlate as well with the elevated gross alpha and beta. This may be due to the constant supply of oxygenated groundwater at this location, where the downward hydraulic differential is greatest (13 feet), counteracting the reducing activities of the anaerobic bacteria. The samples from the three monitoring wells where gross alpha and beta were highest were also analyzed for CH_4, TSS, and VSS. All three samples indicate the presence of dissolved CH_4 (0.025 to 0.116 mg/ℓ) and an increase in organic suspended material with depth (78 and 84 percent VSS in the deep wells), which would be indicative of available carbon and biomass. However, it appears that TDS and volatile dissolved solids would be more indicative of the percent biomass (see Table 4-5). According to Qasim and Chiang (1994), the CH_4, Eh, and pH data at OU 1 are indicative of a landfill beginning the second stage of anaerobic decomposition, when the population of methane-producing bacteria increases, the pH approaches neutral, and the Eh reaches the lowest values.

There appears to be a direct relationship between gross alpha and beta and certain inorganics. This relationship is most obvious between gross alpha and aluminum, barium, beryllium, chromium, and vanadium, as can be deduced from the graphs in Appendix I-6. The correlation coefficients for gross alpha activity and concentrations of these inorganics are 0.83, 0.75, 0.85, 0.83, and 0.86, respectively, when the three highest outlying concentrations detected in samples from OLD-U1-03, -28, and -29 are factored out of the calculations. Because of the high correlation between gross alpha and vanadium, the radionuclides are believed to be originating from the phosphates and vanadates (PO_4 and VO_4 commonly substitute for each other) in the Hawthorn Group sediments. Weathered fluorapatite (the "leached zone") produces aluminum phosphates, the reduction of which may account for the increased aluminum. Beryllium can substitute for calcium in fluorapatite. The increase in barium and chromium indicates that barium sulfate and chromates may be present in the Hawthorn sediments.

The graphs also show that the inorganics are more closely related to gross alpha activity than to gross beta, which usually exceeds alpha and is more variable. This indicates that while the reduction of the phosphates may explain the gross alpha, this may not account for most of the gross beta, unless vanadium-50, lanthanum-138, or thorium-234, naturally occurring isotopes of possible elements found in some phosphates or vanadates, are contributors. This possibility could explain the high gross beta (102 pCi/ℓ) in the groundwater sample collected from OLD-U1-14B, which is screened in a phosphorite sand layer. However, the beta emitters in the uranium-238 series (not analyzed) could just as likely be a source. Another likely source for the gross beta activity is naturally occurring potassium-40 or rubidium-87 coming from the reduction of clay particles such as illite (K and/or Ba are elevated in samples from OLD-U1-03C, -06C, -26B, and -27C). Yet another possible source for the beta emission is carbon-14 from the leachate created by the decay of wood (yard and construction debris) buried in the landfill.

To gain a better understanding of the degree to which the site's radiological parameters are elevated, the gross alpha and beta measurements obtained from OU 1 were compared with a set of those in FDEP's statewide background groundwater quality database. This particular comparison was made because of the need to put the OU 1 radiological data into a larger perspective, but unfortunately, there are no other radiological data available, especially more local to NTC, Orlando.

To compare measurements from similar hydrogeologic environments, only data from wells screened in the surficial aquifer and located in the St. Johns River Water Management District were used. This data set includes 73 background monitoring wells located in areas believed to be uncontaminated. These areas are located in 19 counties. The data set includes six wells in Orange County. No phosphate mines are present in this region, which would have biased the comparison. Although the lithology at the screened section of the FDEP background wells is not known, the depth of the wells, which ranged from 6 to 86 feet bls, is provided (Appendix I-5, pages I-5-124 and -125). Even though both data sets represent the surficial aquifer from shallow to deep depths, it is the percentage of wells in the basal zone in each data set that will determine the usefulness of the comparison. The OU 1 deep wells ranged from 47.5 to 69.5 feet bls and represent 33.3 percent of the data set. The percentage of wells with depths ranging from 46 to 86 feet in the FDEP data set is 23.3. Although the FDEP data set has a higher percentage of shallow well data, the majority of elevated gross alpha and beta values were from shallow wells (45 feet or less in depth).

The Mann-Whitney U test was used to compare populations. The results (Table 4-4, Appendix I-5) indicate that there is no evidence of different populations in terms of gross alpha, but that two different populations are seen in terms of gross beta, with the OU 1 data set being higher. The median values for gross alpha were 3.7 and 3.0 for the OU 1 and FDEP data sets, respectively, whereas the median values for gross beta were 7.2 and 4.65, respectively. The best explanation for the different beta populations appears to be that OU 1, unlike the other sampling locations in the St. Johns River Water Management District, has a landfill that has affected the groundwater chemistry. Because of the leachate generated by the landfill, either carbon-14 has been elevated by the decaying wood, or the leachate induced-anaerobic microbial activity has elevated potassium-40 by reducing the clay particles.

Regression statistics were also run on the turbidity and gross alpha values at OU 1 to determine the degree of correlation. The correlation coefficient is 0.88, indicating a strong correlation. This explains why gross radioactivity was elevated in the groundwater at monitoring wells OLD-U1-28B and -29C, which are located upgradient of the landfill. For some unknown reason, the turbidity (TSS) in this area is high, indicating that the upper zone of the Hawthorn Group is leached and the associated radioisotopes are mobilized.

<u>4.4 SUMMARY OF NATURE AND DISTRIBUTION OF CONTAMINATION</u>. The contaminants at OU 1 that exceed background and/or regulatory limits appear to be limited to PAHs in a small area of surface soil and elevated radiological contamination in the basal zone of the surficial aquifer in the immediate vicinity of the landfill.

4.4.1 Surface Soil Because the small area of surface soil contamination is adjacent to the old firefighter training pit used by the Army Air Corps and US Air Force, the PAHs are believed to have either originated from wind blown ash from burning objects in the fire pit, or from earth-moving activities during development of the parade field and spreading of the contaminated soil away from the pit. In either case, the PAH contamination does not appear to be related to the landfilled material and, therefore, only pertains to the quality of the landfill cover.

The pesticides, a PCB, and inorganics detected in the surface soil are believed to be postlandfill contaminants related to the use of the area as a marching parade field.

4.4.2 Groundwater The radiological contamination in the groundwater appears to be caused indirectly by the landfill leachate (anaerobic microbial activity), as opposed to directly by leachate from buried radioactive material in the landfill. This was concluded from the facts discussed below.

- The elevated gross alpha and beta activity only occur in the immediate vicinity of the landfill and only near the base of the surficial aquifer, where there are phosphorite sands associated with the Hawthorn Group. None of the samples from downgradient wells (shallow to deep) outside the immediate vicinity of the landfill had elevated radiological contamination, nor did the shallow wells in the same clusters where elevated radiological contamination occurs at depth.

- The samples with elevated gross alpha and beta activity also have elevated inorganics such as Al, Ba, Be, Cr, V, as well as pH, total P, TDS, TOC, and alkalinity (comparing these last five parameters in samples from downgradient well clusters OLD-U1-10A through -12C and OLD-U1-16A through -18C vs. well cluster OLD-U1-25A through -27C; see Appendix I-3).

- Evidence of anaerobic microbial activity was found in the groundwater where elevated gross alpha and beta occurs, such as higher TOC and TDS, lower Eh and DO, the presence of CH_4, and a significant percent VSS.

- A mechanism for transporting leachate steeply downward is found in the significant downward head differential (3 to 13 feet) between the upper and lower zones of the surficial aquifer on the west and south sides of the landfill. This differential may be caused by the topographic high recharge area located to the south and southwest of the landfill equalibrating with the lower regional water table.

- In a reducing environment created by increased microbial activity, the solubilization and/or reduction of uranium phosphates and vanadates, radium and barium sulfates, and potassium clay minerals (micas) would put available cations into solution, including the radioactive isotopes associated with these minerals.

5.0 CONTAMINANT FATE AND TRANSPORT

This chapter evaluates the fate and transport of contaminants detected in the environment at OU 1. Results of the site's physical characteristics, source characteristics, and extent of contamination analysis in the previous chapters are combined in this evaluation. The observed extent of contamination, presented in Chapter 4.0, is used as the basis for assessing the transport pathway's rate of migration and the fate of contaminants over the period between the possible time of release and current conditions. Because of the limited nature of contamination in the surface soil and groundwater at OU 1 and the apparent lack of a discernable plume of contamination beyond the fringes of the landfill, no detailed analytical or numerical models were developed. Rather, this discussion relies primarily on a simplistic model utilizing the chemical characteristics of identified contaminants and interpretation of existing migration patterns.

5.1 POTENTIAL ROUTES OF MIGRATION. The leaching of contaminants from the surface soil into surrounding soil and groundwater is the primary potential migration mechanism for the transport of identified soil contaminants. For groundwater, the primary potential migration mechanism is groundwater flow that serves to transport contaminants away from the source areas at OU 1. As discussed previously in Chapter 3.0, the groundwater flow is generally in a northeast direction. Site contaminants do not appear to be transported beyond the fringes of the landfill at concentrations exceeding levels of concern.

5.2 PERSISTENCE AND FATE OF OU 1 CONTAMINANTS. The persistence and fate of PAHs detected in the surface soil and radionuclides detected in the basal zone of the surficial aquifer are discussed in this section.

5.2.1 SVOCs Semivolatile organics detected in the surface soil (landfill cover) that are considered to be a concern (exceed RBCs and SCGs) at OU 1 are Arochlor-1260, benzo(a)-pyrene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. These SVOCs have low water solubility and high sorption to soil or organic matter, which inhibit leaching or volatilization, and, therefore, are unlikely to migrate from their original location. The persistence is, therefore, strong, with mobilization and migration being minimal. As long as the asphalt pavement continues to cover the area where the concentration of PAHs is highest, the immobilization of the PAHs is not expected to change. None of the PAHs detected in the soil have been detected in any of the groundwater analyses at OU 1. Therefore, as a landfill cover, the elevated PAHs in the surface soil are not expected to adversely affect the groundwater quality beneath the landfill. However, the proposed reuse of this property as a park may pose a risk to humans using the property when the asphalt is removed, exposing the surface soils. This will be addressed in Chapter 6.0, Human Health Risk Assessment.

5.2.2 Radiological Compounds Elevated (above background or MCL) gross alpha and/or beta were detected in groundwater samples from intermediate to deep monitoring wells located along the perimeter of the landfill (OLD-U1-03C, -06C, -14B, -15C, -26B, and -27C). One shallow monitoring well (OLD-U1-07A) also had elevated gross beta alone. Not all potential contributing radionuclides were tested, but the specific radionuclides known to significantly contribute to gross alpha and beta are uranium-238 and -234, thorium-230 and -228, radium-226 and -228, and potassium-40. When the elevated radioactive constituents are correlated with the hydrogeology and other groundwater chemistry data, one may reasonably conclude that the radiological contamination is due to mobilization of naturally occurring radionuclides rather than to buried radioactive material in the landfill. The natural uranium-238 series radioisotopes, which are known to be associated with the phosphates of the Hawthorn deposits, appear to be mobilized in the vicinity of the landfill and do not occur farther downgradient.

This mobilization is best explained by a change in groundwater chemistry due to the enhancement of microbial activity by the landfill leachate. The organics in the leachate are transported downward by a steep downward hydraulic head differential in the southwest corner of the landfill, thereby enhancing the activity and density of the indigenous bacteria in the basal zone of the surficial aquifer. As long as the landfill produces leachate and the microbial activity continues to cause the phosphates, vanadates, sulfates, and micas to be reduced, the radionuclides associated with these compounds will continue to be mobilized into the aquifer. As the landfill ages and the available leachate (carbon) decreases, the population of methane-producing anaerobic bacteria will increase, but as pH becomes neutral, the conductivity will fall and the solubility of inorganics will decrease (Qasim and Chiang, 1994). Eventually, as fresh groundwater moves through, the groundwater chemistry below the landfill will return to background.

Farther downgradient from the landfill, the leachate is diluted and there is less available carbon, so the anaerobic bacteria density is normal. As the low Eh groundwater mixes with oxygenated groundwater, uranyl complexes form (which are readily sorbed on colloidal particles such as organics, ferric hydroxides, and clays), causing the uranium isotopes to be largely precipitated out of solution, reducing radionuclide activity below levels of concern. It appears that natural conditions outside the zone affected by leachate prevent downgradient migration of the mobilized radionuclides. Therefore, downgradient surface water bodies, such as Lake Spier and Lake Berry, are apparently not threatened by elevated radionuclides at the landfill.

6.0 HUMAN HEALTH RISK ASSESSMENT (HHRA)

6.1 HHRA. An HHRA has been conducted as part of the RI completed for NTC, Orlando OU 1. The purpose of the HHRA is to characterize the human health risks associated with potential exposures to site-related contaminants in environmental media present at and migrating from the former North Grinder Landfill.

This section includes the characterization of the risks associated with potential exposures to site-related contaminants detected at OU 1 for human health receptors. This risk assessment is organized as follows: Section 6.1 includes seven subsections: Subsection 6.1.1 Data Evaluation; Subsection 6.1.2 Selection of Human Health Chemicals of Potential Concern; Subsection 6.1.3 Exposure Assessment; Subsection 6.1.4 Toxicity Assessment, and Subsection 6.1.5 Risk Characterization, including uncertainty analysis; Subsection 6.1.6 is the human health risk assessment summary; and following the risk assessment is a presentation of remedial goal options, Subsection 6.1.7. Appendices J-1 through J-9 provide documentation of various aspects of this risk assessment.

This HHRA is conducted in accordance with the USEPA's *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)* (USEPA, 1989a), Guidance for Data Useability in Risk Assessment (Part A), Final (USEPA, 1992a), Region IV Risk Assessment Guidance (USEPA, 1995a) and will consider FDEP guidance, particularly, Soil Cleanup Goals for Florida (FDEP, 1995), FDEP Drinking Water Standards (FDEP, 1994) and numerous other USEPA guidance documents and directives (USEPA, 1986a, 1989b, 1991a, 1992b, 1992c, 1992d). The HHRA is conducted to determine if contamination at the North Grinder Landfill (OU 1) poses potential health risks of concern to individuals under current and/or foreseeable future site conditions in the absence of remediation. The HHRA consists of several components: data evaluation, identification of CPCs, exposure assessment, toxicity assessment risk characterization (including uncertainty analysis) (USEPA, 1989a), a risk assessment summary, and discussion of remedial goal options. Collectively, these components are used to identify site-related contaminants and estimate the potential magnitude of exposure and the risks resulting from the estimated exposure conditions. An overview of the technical approach to be used in the NTC, Orlando OU 1 HHRA is presented here.

The location, physical description, and history associated with the North Grinder Landfill are described in Section 1.2. Surface soil and groundwater samples were collected during the RI (Section 2.2). After evaluation and management of the environmental data collected at the North Grinder Landfill (Chapter 2.0), HHCPCs were selected and the potential human health risks associated with each medium at the North Grinder Landfill were characterized.

6.1.1 Data Evaluation The data evaluation involves numerous activities: sort data by medium, evaluate analytical methods, evaluate quantitation limits, evaluate quality of data with respect to qualifiers and codes, evaluate tentatively identified compounds, compare potential site-related contamination with background, develop data set for use in risk assessment, and identify CPCs. After a brief summary of the sampling and analysis activities conducted to date is presented, a description of each of these activities is provided below.

Available Data. A thorough discussion of all data collection activities and a presentation of the analytical data are provided in the previous sections of this RI report and its appendices. The available analytical data for OU 1 consist of landfill cover (referred to as surface soil) and groundwater sampling and analytical results.

6.1.1.1 **Evaluate the Analytical Methods** A detailed discussion of the analytical methods employed in developing analytical environmental data is presented in the RI report. The data used in this risk assessment will be the result of analyses conducted under the CLP with documented QA/QC procedures. The analytical data will be further evaluated for useability in the quantitative risk assessment evaluating quantitation limits, evaluating qualified and coded data, comparing concentrations detected in samples to concentrations detected in blanks, and by evaluating tentatively identified compounds (TICs).

6.1.1.2 **Evaluate Quantitation Limits** Sample quantitation limits (SQLs) are compared to Federal RBCs and State SCGs for soil. SQLs are also compared to Federal MCLs, Florida Drinking Water Standards, and Florida Groundwater Guidance Concentrations for groundwater. Analyte-specific SQLs that are above RBCs are identified so that uncertainties in risk estimates for those analytes can be discussed.

The notable situations where the highest reported SQLs exceed an RBC for residential soil or a Florida residential SCG include benzo(a)pyrene and dibenz(a,h)anthracene (highest reporting limit 350 μg/kg) with RBCs and SCGs of 88 μg/kg and 100 μg/kg respectively. This does not have a large impact overall, because residential use is prohibited and industrial land-use screening values are 500 μg/kg or higher. The highest reporting limit for Aroclor-1260 in soil was 180 μg/kg, which is higher than the residential RBC of 83 μg/kg but below the Florida SCG of 900 μg/kg. This does not have a large impact overall, because residential use will be prohibited by institutional controls.

Overall, SQLs are adequate to insure that concentrations of concern from a risk or regulatory perspective could be detected and quantified.

6.1.1.3 **Evaluate Qualified and Coded Data** Both the laboratory and data validators may assign qualifiers to analytical results. The qualifiers assigned by the data validators supersede the laboratory qualifiers. The results of the data validation will be discussed in the RI report, and the validated data, with qualifiers, are presented in Appendices to that report. All positive detections (whether they are unqualified or qualified with a "J") have been considered detected concentrations for the risk assessment. All nondetects (qualified with a "U") will be retained in the risk assessment data set as samples without positive detections. If all sample results for a given analyte in a given medium are nondetects, then that analyte will not be retained as a detected analyte for the purposes of the risk assessment. Any sample results with an "R" validation qualifier will be eliminated from the risk assessment data set because quality control indicates that the result is unusable.

6.1.1.4 **Compare Concentrations Detected in Samples to Concentrations Detected in Blanks** Sample concentrations have been compared to the concentrations in associated blanks in order to distinguish artifacts from actual presence of analytes in environmental samples. The comparisons will be conducted as part of the data validation process, which has been previously discussed in this RI report. Those sample results considered artifacts will be identified in the RI report.

6.1.1.5 Evaluate Tentatively Identified Compounds TICs (both identity and concentration are uncertain) are reviewed. If the number of TICs is small relative to the TAL and TCL chemicals and there is no historical information to suggest the TICs should be present, the TICs will not be quantitatively evaluated. If the number of TICs is large relative to the TAL and TCL chemicals, the TICs will be included in the quantitative evaluation, and the uncertainty in the identity and concentrations of these analytes will be fully discussed in the uncertainty analysis.

6.1.1.6 Develop Data Set for Use in Risk Assessment Data management concludes with the summarization of data and statistics generation for each data set. Summary tables provide the chemical name, the frequency of detection, the minimum and maximum detected concentrations, the units associated with the results, the minimum and maximum quantitation limits, and the average of the detected concentrations. These tables are produced for each medium at OU 1. The data sets used in the risk assessment are identified in the HHCPC Selection Tables (Subsection 6.1.2).

<u>6.1.2 Selection of Human Health Chemicals of Potential Concern (HHCPCs)</u> HHCPCs are defined as chemicals for which data of sufficient quality are available for use in the risk assessment, that are potentially site related, and that have maximum detected concentrations that are above standards or guidelines; above risk-based screening concentrations (where available); and, for inorganic analytes, above background screening concentrations (where available). The methodology used to select HHCPCs is described here.

Contaminants for which data of sufficient quality are available for use in the risk assessment and that are present at concentrations greater than those measured at background locations are the starting point for the development of the list of CPCs. The final list of CPCs is generally a subset of all compounds detected in the various media and are selected based on concentration and frequency of detection; physical, chemical, and toxicological characteristics; and comparison of detected values to background, associated blanks, and risk-based values.

In selecting HHCPCs, USEPA criteria will be used (USEPA, 1989a). HHCPCs at OU 1 will include chemicals that are positively identified in at least one sample. For each medium at OU 1, the following criteria will be employed to exclude detected analytes from the list of HHCPCs. Each criterion by itself is justification for excluding the analyte:

A. The maximum reported site concentration is less than two times the reported average background concentration (inorganics only) calculated from background sampling location data (USEPA, 1995a). Details of this approach are presented in Paragraph 6.1.2.1.

B. The maximum reported concentration in a given medium is less than the corresponding risk-based screening concentration(s) and applicable ARARs. Risk-based screening concentrations are obtained from USEPA and the State of Florida regulations and guidance documents. In situations where multiple screening values are available, a chemical is excluded only if its maximum concentration is less than all of the corresponding screening values. Paragraphs 6.1.2.2 and 6.1.2.4 and Appendices J-1 and J-2 provide additional detail concerning risk-based screening, regulatory guidance values, and ARARs that are used in CPC selection.

C. The average concentration of an essential nutrient (sodium, potassium, magnesium, iron, and calcium) in a medium is below a toxic level and consistent with or only slightly above the background concentration for that essential nutrient. The HHCPC selection process for essential nutrients is further described in Paragraph 6.1.2.3 and Appendix J-3.

D. The concentrations are within 5 times or 10 times the concentrations in associated blanks (USEPA 1989a, USEPA 1992a). This evaluation is conducted as part of the data validation process (which is described in the RI report).

E. Having a frequency of detection (number of samples in which the analyte is detected divided by the number of samples analyzed for that analyte) of less than 5 percent when there is a minimum of 20 samples (USEPA, 1989a) and the analyte is not a CPC in another medium.

The selection of a carcinogenic PAH as a CPC in a particular medium required that other carcinogenic PAHs detected in that medium be returned as a CPC, even if their maximum detected concentrations are less than the available screening values (USEPA, 1989). Medium-specific HHCPCs for human health are identified for each medium at OU 1. Chemicals not identified as HHCPCs are clearly identified and the justification for their exclusion noted. Transformation products or parent compounds of HHCPCs are not deleted from the HHCPC list.

6.1.2.1 **Background Data** The baseline risk assessments being conducted at OU 1 use a background screening concentration as part of the HHCPC selection per USEPA Region IV guidance (USEPA, 1995a). The Region IV guidance states that HHCPCs would include "inorganics which are detected at concentrations significantly above background samples (the criteria for determining significance should generally be 2 times the background concentration)". This statement applies to all media. The screening criterion has been further defined as a comparison of the maximum detected potential source of contamination concentration to two times the arithmetic mean of the background location samples (USEPA, 1995a).

The comparison is conducted as follows. Maximum detected OU 1 concentrations are compared to two times the background mean concentration for inorganics. Organic analytes are not considered in the background evaluation. If the maximum OU 1 concentration is below two times the arithmetic mean of the background location samples, the analyte is considered to be consistent with background location concentrations. This approach is conservative in that it is likely to identify certain analytes as being inconsistent with background (including them as HHCPCs) even though the distribution of concentrations onsite is very similar to that of the background data set. The documentation of the background data sets, including sample lists and statistics, appears in the Background Sampling Report (ABB-ES, 1995a).

6.1.2.2 Risk-Based Screening Tables of medium-specific risk-based concentrations and standards and guidelines are presented in Appendices J-1 and J-2. The USEPA Region III Risk-Based Concentration Table's (USEPA, 1995b) residential soil RBCs (adjusted for a hazard quotient of 0.1) and FDEP's SCGs for Florida are used to select HHCPCs in surface soil. Because there are no complete exposure pathways for groundwater at OU 1, HHCPCs will not be selected for groundwater. Maximum groundwater concentrations will not be compared to Federal (USEPA, 1995c) and State MCLs (Florida Legislature, 1994a) because there are no current or potential uses of groundwater as drinking water. Concentrations will be compared to FDEP groundwater standards (Florida Legislature, 1994b) and groundwater guidance values (which include Primary and Secondary standards) (FDEP, 1994b), but this comparison is not conducted to assess human health risk.

For a given medium, the maximum reported concentration at OU 1 will be compared to the corresponding screening value. If the maximum reported concentration is greater than the screening concentration, the contaminant will be selected as an HHCPC. However, if the maximum reported concentration is less than the risk-based concentration, the analyte will not be selected as an HHCPC unless it is a parent compound or transformation product of another CPC.

No RBC is available for lead in soil. Based on USEPA recommendation, a target level for cleanup at Superfund sites for lead of 400 milligram per kilogram (mg/kg) is used as the RBC for lead in soil (USEPA, 1994a). The published Florida Soil Cleanup Goal for lead is 500 mg/kg (FDEP, 1995). The risk-based screening value does not address potential leaching of analytes from soil to groundwater.

<u>Total Petroleum Hydrocarbons (TPH)</u>. When collected, TPH data in soil as well are compared to the available Florida guidance value of 50 mg/kg. The Florida guidance value is defined in the Florida Administrative Code (FAC) under criteria for clean soil that has been thermally treated after contamination with petroleum (Florida Legislature, 1992a). This criterion may not be directly applicable to soil, but may provide some regulatory perspective.

6.1.2.3 Essential Nutrients In the HHRA, analytes that are considered essential nutrients include sodium, potassium, magnesium, and calcium. If an essential nutrient is present at a concentration (arithmetic mean) that is below a toxic level (as defined in Table 6-1) and consistent with or only slightly above the background concentration (twice the reference mean) the analyte is eliminated as a HHCPC for the HHRA. The derivation of the essential nutrient screening values is presented in Appendix J-3. This approach is consistent with general USEPA guidance on essential nutrients (USEPA, 1989a).

The Risk Assessment Guidance for Superfund (RAGS), Volume I, Part A, regarding the evaluation of essential nutrients (calcium, iron, magnesium, potassium, and sodium) in a public health or ecological risk assessment, states that essential nutrients need not be quantitatively evaluated if they are (1) present at low concentrations (only slightly above background) and (2) toxic only at doses much higher than those that might be related to exposure at the site (USEPA, 1989a). In this report, "only slightly above background" is interpreted to mean that the

Table 6-1
Essential Nutrient Screening Concentrations for Surface Soil and Groundwater

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Essential Nutrient	Surface Soil Screening Concentration (mg/kg)	Groundwater Screening Concentration ($\mu g/\ell$)
Calcium	1,000,000 [1]	1,055,398
Magnesium	460,468	118,807
Potassium	1,000,000 [1]	297,016
Sodium	1,000,000 [1]	396,022

[1] Actual calculated screening concentration is greater than 1,000,000 mg/kg (Table 5), indicating that this essential nutrient would not be present at toxic levels in surface soil.

Notes: mg/kg = milligrams per kilogram.
$\mu g/\ell$ = micrograms per liter.

arithmetic mean of the site concentrations is less than two times the arithmetic mean of the detected background concentrations. Essential nutrients that are detected at concentrations that are consistent with background or at concentrations considered essentially "nontoxic" are considered to be contaminants that would not cause a public health concern and, therefore, are not further evaluated in the risk assessment.

6.1.2.4 Regulatory Guidance Regulatory guidance available for the NTC, Orlando OU 1 RI and HHRA includes the Federal drinking water standards which are called MCLs (USEPA, 1995c), Florida Primary and Secondary Standards applied to groundwater (Florida Legislature, 1994a; 1994b), and Florida "free froms." Based on the water quality standards for the State of Florida (FDEP, 1994b) under Section 62-3.402, FAC, groundwater must be "free from" domestic, industrial, agricultural, or other manmade nonthermal components in concentrations that could cause harm to human health, especially cancer (62-3.402(b)). The State of Florida recognizes Florida Primary Standards (62-3.402(b)) to be the best guidance available for determining safe drinking water concentrations of contaminants; however, Florida groundwater guidance concentrations are also considered (FDEP, 1994).

There is also the FDEP memorandum, "Soil Cleanup Goals for Florida," September 29, 1995 (FDEP, 1995a). This memorandum contains a listing of "selected Soil Clean-up Goals" for residential and industrial exposure scenarios for surface soil as well as a soil cleanup goal based on leachability to groundwater. The published FDEP Soil Cleanup Goals for leachability are available only for organics. This guidance will be used, based on communications with the FDEP, for screening in CPC selection.

No analyte is eliminated from the HHCPCs list without some justification if the maximum concentration exceeds an applicable enforceable regulatory standard (for example, MCLs and Florida Primary or Secondary Standards for drinking water situations). For those substances that do not currently have a Federal MCL or Florida Primary Standard, appropriate screening takes place using the risk-based concentration screen. This comparison supplies a risk-based comparison and is appropriate for selection of HHCPCs. Those analytes with concentrations that exceed MCLs or other standards are identified.

6.1.2.5 Surface Soil Fourteen surface soil samples and two duplicates were collected at the North Grinder Landfill and submitted for chemical analysis during the RI. These "surface soil" samples were actually samples of landfill cover materials which were taken to evaluate the quality of the cover material and to evaluate the potential exposure to the cover material and landfill materials. Surface soil sample locations evaluated in the HHRA (U1S00100 through U1S01400, including the two duplicates U1S00100D and U1S01100D) are indicated on Figure 2-5.

Table 6-2 presents the analytes detected in and the HHCPCs selected for the surface soil at the North Grinder Landfill. Seven SVOCs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz-(a,h)anthracene, and indeno(1,2,3-cd)pyrene), two pesticides (Dieldrin and gamma-BHC [Lindane]), one PCB (Aroclor-1260), and one inorganic analyte (arsenic) were selected as HHCPCs.

Table 6-2
Selection of Human Health Chemicals of Potential Concern
Surface Soil

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Orlando, Florida

Chemical	Frequency of Detection [1]	Range of Reporting Limits	Range of Detected Concentrations	Mean of Detected Concentrations[3]	Background Screening Concentration[4]	Risk-Based Screening Concentration[5]	Florida Leaching Value [6]	Florida Cleanup Goal[7]	Selected as HHCPC? (Yes/No)
<u>Volatile Organic Compounds</u> (μg/kg)									
Acetone	13/14	10 - 11	6 - 18	9	NA	780,000	NG	260,000	No,S
<u>Semivolatile Organic Compounds</u> (μg/kg)									
Acenaphthene	1/14	340 - 350	100 - 100	100	NA	470,000		2,800,000	No,S
Anthracene	1/14	340 -350	130 -130	130	NA	2,300,000		20,000,000	No,S
Benzo(a)anthracene	3/14	340 - 350	120 - 480	263	NA	880	NG	1,400	Yes,C
Benzo(a)pyrene	3/14	340 - 350	200 - 1,200	600	NA	88	NG	100	Yes
Benzo(b)fluoranthene	2/14	340 - 350	250 - 410	330	NA	880	NG	1,400	Yes,C
Benzo(g,h,i)perylene	4/14	340 - 350	120 - 2,500	798	NA	NSC	NG	14,000	No,S
Benzo(k)fluoranthene	3/14	340 - 890	210 - 4,000	1,533	NA	8,800	NG	14,000	Yes,C
Carbazole	1/14	340 - 350	93 -93	93	NA	32,000		42,000	No,S
Chrysene	3/14	340 - 350	210 - 500	327	NA	88,000	NG	140,000	Yes,C
Dibenz(a,h)anthracene	2/14	340 - 350	120 - 760	440	NA	88	NG	100	Yes
Fluoranthene	4/14	340 - 350	93 - 1,100	451	NA	310,000	NG	2,900,000	No,S
Indeno(1,2,3-cd)pyrene	3/14	340 - 350	160 - 2,300	913	NA	880	NG	1,400	Yes
Phenanthrene	2/14	340 - 350	150 - 620	385	NA	NSC	NG	1,700,000	No,S
Pyrene	3/14	340 - 350	160 - 1,100	530	NA	230,000	NG	2,200,000	No,S
bis(2-Ethylhexyl)phthalate	3/14	340 - 350	180* - 280	223	NA	46,000	11,000	48,000	No,S

See notes at end of table.

Table 6-2 (Continued)
Selection of Human Health Chemicals of Potential Concern
Surface Soil

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Chemical	Frequency of Detection[1]	Range of Reporting Limits	Range of Detected Concentrations	Mean of Detected Concentrations[3]	Background Screening Concentration[4]	Risk-Based Screening Concentration[5]	Florida Leaching Value[6]	Florida Cleanup Goal[7]	Selected as HHCPC? (Yes/No)
Pesticides and PCBs (μg/kg)									
4,4-DDD	1/14	3.4 - 18	3.5 - 3.5	3.5	NA	2,700	NG	4,500	No,S
4,4-DDE	8/14	3.4 - 18	1.8 - 43	14.8	NA	1,900	NG	3,000	No,S
4,4-DDT	6/14	3.4 - 18	2 - 48	16.3	NA	1,900	NG	3,100	No,S
Aroclor-1260	6/14	34 - 180	35 - 150	82	NA	83	NG	900	Yes
Dieldrin	7/14	3.4 - 34	3.8 - [2]175	56	NA	40	NG	70	Yes
Heptachlor epoxide	3/14	1.7 - 9.2	4.3 - [2]6.85	5.9	NA	70	NG	100	No,S
alpha-Chlordane	11/14	1.7 - 18	1.1 - 85	22.8	NA	490		800	No,S
gamma-BHC (Lindane)	1/14	1.7 - 9.2	[2]1.025 - [2]1.025	1.2	NA	NSC		NSC	Yes
gamma-Chlordane	10/14	1.7 - 18	1 - 53	16.4	NA	490		800	No,S
Inorganic Analytes (mg/kg)									
Aluminum	14/14	4.3 - 4.8	182 - 1,030.5	616	2,088	7,800	NC	75,000	No,B
Arsenic	10/14	0.38 - 0.425	0.42 - [2]2.7	1.28	0.851	0.43	NC	0.7	Yes
Barium	14/14	0.12 - 0.13	[2]1.13 - 19.1	7.33	7.85	550	NC	5,200	No,S
Cadmium	4/14	0.57 - 0.66	0.8 - [2]1.6	1.3	0.55	3.9	NC	37	No,S

See notes at end of table.

Table 6-2 (Continued)
Selection of Human Health Chemicals of Potential Concern
Surface Soil

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Chemical	Frequency of Detection[1]	Range of Reporting Limits	Range of Detected Concentrations	Mean of Detected Concentrations[3]	Background Screening Concentration[4]	Risk-Based Screening Concentration[5]	Florida Leaching Value[6]	Florida Cleanup Goal[7]	Selected as HHCPC? (Yes/No)
Inorganic Analytes (mg/kg) (Continued)									
Calcium	14/14	2.8 - 3.15	305 - 119,000	32,406	25,295	1,000,000		NSC	No,E
Chromium	14/14	0.62 - 0.685	[2]1.2 - 26.8	7.1	4.6	39	NC	290	No,S
Copper	9/14	0.28 - 0.315	2.3 - 15.2	7.5	2.27	NSC	NC	NSC	No,E
Iron	14/14	0.89 - 1	109 - 944	334	712	2,300	NC	NSC	No,S
Lead	14/14	0.3 - 0.335	1.4 - 24.3	56	14.5	400	NC	500	No,S
Magnesium	12/14	4 - 4.45	59.5 - 922	315.9	328	460,468		NSC	No,E
Manganese	14/14	0.14 - 0.155	1.5 - 11.7	6.2	8.1	39		370	No,S
Mercury	10/14	0.02 -0.026	0.02 - 0.74	0.15	0.032	0.78	NC	23	No,S
Potassium	1/14	89.3 - 98.9	105 - 105	105	93.4	1,000,000	NC	NSC	No,B,E
Silver	3/14	0.52 - 0.575	[2]1.88 - 6	3.7	0.758	39	NC	390	No,S
Thallium	1/14	0.37 - 0.415	0.39 - 0.39	0.39	1.1	0.63	NC	NSC	No,B
Vanadium	11/14	0.5 - 0.555	0.54 - 5.8	2.36	2.90	55	NC	490	No,S
Zinc	14/14	0.22 - 0.245	2.6 - 60.1	22.1	14.8	2,300		23,000	No,S
Total Petroleum Hydrocarbons	14/14	4 - 4	10.1 - [2]65.05	34.2	NA	NSC	NC	NSC	Yes

See notes at end of table.

Table 6-2 (Continued)
Selection of Human Health Chemicals of Potential Concern
Surface Soil

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed. The following samples were analyzed: U1S00100 through U1S01400 and two duplicates, U1S00100D and U1S01100D.
[2] The average of the detected concentration in a sample and its duplicate. For non-detect values, one-half of the contract-required quantitation limit or contract-required detection limit is used as a surrogate.
[3] The mean of detected concentrations is the arithmetic mean of all samples in which the analyte was detected. It does not include those samples in which the analyte was not detected.
[4] The background screening concentration is twice the mean of detected concentrations for inorganic analytes. The samples included in the background data set are identified in Table 5-1 of the Background Sampling Report (ABB Environmental Services, Inc. [ABB-ES], 1995a).
[5] The risk-based screening concentrations are identified in Appendix J-1.
[6] The Florida leaching values (September 29, 1995) are identified in Appendix J-2.
[7] The Florida soil cleanup goals (September 29, 1995) are identified in Appendix J-2.

Notes: S = Analyte is not retained as a n HHCPC because maximum reported concentration is less than the risk-based screening concentrations (RBCs and Florida Leaching Concentration and Cleanup Goals).
B = Analyte is not retained as an HHCPC because maximum reported concentration is less than the background screening concentration.
E = Analyte is not retained as an HHCPC because maximum reported concentration is less than the essential nutrient screening concentrations derived in Appendix J-3.
C = Analyte is retained as an HHCPC because it is a member of a chemical class that contains HHCPCs (carcinogenic polynuclear aromatic hydrocarbons [PAHs]).

HHCPC = human health chemical of potential concern.
μg/kg = micrograms per kilogram.
NA = not applicable.
NG = not detected in groundwater.
PCBs = polychlorinated biphenyls.
DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.
NC = not calculated.
NSC = no screening concentration.
mg/kg = milligrams per kilogram.

6.1.2.6 Subsurface Soil No subsurface soil samples were collected at the North Grinder Landfill.

6.1.2.7 Groundwater Nine unfiltered groundwater samples and one duplicate were collected (for traditional parameters and gross alpha and gross beta activity) from each of three groundwater depths within the surficial aquifer (shallow, medium, and deep) using the low-flow sampling method and submitted for chemical analysis. In addition, as a followup to apparently elevated gross alpha and gross beta activities, five additional unfiltered samples were collected and analyzed for gross alpha and gross beta as well as specific radionuclides. Of these samples, a field sample and a duplicate were collected from the shallow portion of the surficial aquifer, two from the medium portion, and two from the deep portion of the aquifer. Groundwater samples are presented in Table 6-3. Groundwater sample locations evaluated in the HHRA are indicated on Figure 2-5.

Subsequently, two monitoring wells, a medium and a deep, were installed farther upgradient of all existing wells (Subsection 2.1.7). These two wells were not considered in the HHRA.

Because there are no complete exposure pathways for groundwater under current or potential future uses of the site, groundwater was not quantitatively evaluated in this assessment. The site is the location of a former landfill, and deed restrictions will prohibit installation of wells within the boundaries of the site. As indicated in Chapters 4.0 and 5.0, there is no identifiable plume of groundwater contamination. The data indicate some samples adjacent to the landfill contain gross alpha and gross beta levels that are above Federal MCLs and Florida Primary Standards. Some downgradient or sidegradient monitoring wells (OLD-U1-14B, OLD-U1-08B, OLD-U1-23B, and OLD-U1-17B) have analytes that exceed MCLs or Florida secondary standards. The analytes are gross alpha, thallium, and iron. There is no indication that there is elevated radiological activity in groundwater downgradient from the boundary of the former landfill and no suggestion that migration of elevated radiological activity in groundwater would be expected in the future. Table 6-4 presents the analytes detected in groundwater at the North Grinder Landfill. One SVOC (bis-2-Ethylhexylpthalate), one pesticide (4,4-DDT), five inorganics (arsenic, beryllium, iron, manganese, and vanadium) and one radiological parameter (gross alpha) exceed Florida drinking water standards. This comparison of groundwater maximum concentrations to Florida drinking water standards shows that the groundwater is unsuitable as a source of drinking water and, therefore, requires institutional controls to prevent such use.

6.1.2.8 Surface Water No surface water samples were collected at the North Grinder Landfill.

6.1.2.9 Sediment No sediment samples were collected from the North Grinder Landfill.

<u>6.1.3 Exposure Assessment</u> The exposure assessment is conducted to estimate the pathways by which humans are potentially exposed, the magnitude of actual and/or potential human exposure, and the frequency and duration of exposure. This process is performed for both current and future site land uses. This process involves several steps:

Table 6-3
Groundwater Samples Considered in Risk Assessment

Remedial Investigation, Operable Unit One
Naval Training Center Orlando
Orlando, Florida

Shallow Groundwater Samples	Medium Groundwater Samples	Deep Groundwater Samples
U1G00101	U1G00201	U1G00301
U1G00401	U1G00501	U1G00601
U1G00701	U1G00801	U1G00901
U1G01001	U1G01101	U1G01201
U1G01001D	U1G01401	U1G01501
U1G01301	U1G01701	U1G01801
U1G01601	U1G01701D	U1G02101
U1G01901	U1G02001	U1G02401
U1G02201	U1G02301	U1G02701
U1G02501	U1G02601	U1G02701D
ORG00103	U1G01403	U1G00303
ORG00103D	U1G02603	U1G02703

Table 6-4
Comparison of Groundwater Concentrations to Florida Drinking Water Standards

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Chemical	Frequency of Detection[1]	Range of Reporting Limits	Range of Detected Concentrations	Background Screening Concentration[2]	Florida Groundwater Guidance Concentration[3]	Does Maximum Exceed Screening Value? (Yes or No)
Volatile Organic Compounds (μg/kg)						
1,4-Dichlorobenzene	5/27	10	1 - 8	NA	[4]75	No
Acetone	3/27	10 - 15	4 - [5]32	NA	[6]700	No
Carbon disulfide	2/27	10	4 - [5]5.5	NA	[6]700	No
Cholorbenzene	3/27	10	4 - 5	NA	[4]100	No
Semivolatile Organic Compounds (μg/kg)						
bis(2-Ethylhexyl)phthalate	6/27	10	2 - 30	NA	[4]6	Yes
Dimethylphalate	1/27	10	7	NA	[6]70,000	No
Naphthalene	1/27	10	3	NA	[7]6.8	No
Phenol	1/27	10	1	NA	[7]10	No
Pesticides and PCBs (μg/kg)						
4,4-DDT	1/27	2.5	3.4	NA	[8]0.1	Yes
(2,4-Dichlorophenoxy) acetic acid	1/27	0.1	0.06	NA	[4]70	No
Inorganic Analytes (mg/kg)						
Aluminum	27/27	24.7	62.4 - 35,700	4,067	[9]200	Yes
Arsenic	1/27	1.5 - 14.8	14	5	[4]50	No
Barium	27/27	0.5 - 6.1	3.6 - 596	31.4	[4]2,000	No
Beryllium	6/27	0.2	0.21 - 7.1	ND	[4]4	Yes
Cadmium	6/27	2.4	4.2	5.6	[4]5	No

See notes at end of table.

Table 6-4 (Continued)
Comparison of Groundwater Concentrations to Florida Drinking Water Standards

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Chemical	Frequency of Detection[1]	Range of Reporting Limits	Range of Detected Concentrations	Background Screening Concentration[2]	Florida Groundwater Guidance Concentrations[3]	Does Maximum Exceed Screening Value? (Yes/No)
Inorganic Analytes (mg/kg)						
Calcium	27/27	15.7	1,860 - 128,000	37,000	NSC	No
Chromium	8/27	2 - 13	2.5 - 61.2	7.8	[4]100	No
Copper	13/27	1.4 - 3.2	1.4 - 6	5.4	[9]1,000	No
Iron	26/27	6.1	9.4 - 7,870	1,230	[9]300	Yes
Lead	5/27	1.3 - 3.2	1.5 - 6	4	[4]15	No
Magnesium	27/27	28	428 - 4,550	4,560	NSC	No
Manganese	26/27	0.5 - 2.1	0.86 - 116	17	[9]50	Yes
Mercury	5/27	0.04 - 0.15	0.04 - 0.06	0.12	[4]2	No
Potassium	29/27	403	444 - 28,100	5,400	NSC	No
Selenium	6/27	0.6	0.9 - 3.5	9.7	[4]50	No
Sodium	28/27	220	1,550 - 46,700	18,200	NSC	No
Vanadium	13/27	2.9	3.7 - 104	20.6	[6]49	Yes
Zinc	16/27	1.2 - 5.2	1.2 - 42.6	4	[9]5,000	No
Radiological pCi/ℓ						
Gross alpha	23/27	1 - 3	1.6 - 257	13	[4]15	Yes
Gross beta	26/27	3	3.4 - 240	9.5	NAS	No
Cesium-137	4/4	NA	-0.972 - 0.038	NA	NAS	No
Potassium-40	4/4	NA	5.8 - 28.4	NA	NAS	No
Radium-226	4/4	NA	0 - 8.83	NA	NAS	No
Radium-228	4/4	NA	0 - 1.81	NA	NAS	No
Thorium-227	4/4	NA	0.041 - 0.446	NA	NAS	No

See notes at end of table.

Table 6- 4 (Continued)
Comparison of Groundwater Concentrations to Florida Drinking Water Standards

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Chemical	Frequency of Detection[1]	Range of Reporting Limits	Range of Detected Concentrations	Background Screening Concentration[3]	Florida Groundwater Guidance concentration[4]	Does Maximum Exceed Screening Value? (Yes/No)
Radiological pCi/ℓ (Continued)						
Thorium-228	4/4	NA	0.912 - 4.55	NA	NAS	No
Thorium-230	4/4	NA	2 - 3.43	NA	NAS	No
Thorium-232	4/4	NA	0.086 - 0.386	NA	NAS	No
Uranium-234	4/4	NA	1.48 - 7.74	NA	NAS	No
Uranium-238	4/4	NA	0.956 - 8.72	NA	NAS	No

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the total number of samples analyzed. The following samples were analyzed: .
[2] The background screening concentration is twice the mean of detected concentrations for inorganic analytes. The samples included in the background data set are identified in Table of the Background Sampling Report (ABB Environmental Services, Inc. [ABB-ES], 1995a).
[3] The Florida Groundwater Guidance Concentrations (June, 1994) are identified in Appendix J-2.
[4] Primary Standard.
[5] The average of the detected concentration in a sample and its duplicate. For non-detect values, one-half of the contract-required quantitation limit or contract-required detection limit is used as a surrogate.
[6] Systemic Toxicant.
[7] Organoleptic.
[8] Carcinogen.
[9] Secondary Standard.

Notes: μg/kg = micrograms per kilogram.
NA = not applicable.
PCBs = polychlorinated biphenyls.
NAS = no applicable screening concentration.
DDT = dichlorodiphenyltrichloroethane.
mg/kg = milligrams per kilogram.
NSC = no screening concentration.
pCi/ℓ = picocuries per liter.

- characterization of the exposure setting in terms of physical characteristics and the populations that may potentially be exposed to site-related chemicals;

- identification of potential exposure pathways and receptors; and

- quantification of exposure for each population in terms of the amount of chemical either ingested, inhaled, or absorbed through the skin from all complete exposure pathways.

6.1.3.1 **Characterization of Exposure Setting** In the characterization of the exposure setting for an HHRA, the physical setting and demographics near the waste site are identified. The physical setting is characterized in terms of the following attributes: climate, meteorology, geology, vegetation, soil type, groundwater, and surface water. This information is gathered from previous investigations and is presented elsewhere in this RI. The information generated from the evaluation of the physical setting aids in defining the physical mechanisms that control or influence how people could be exposed at a waste site and provides information on the potential migration of contaminants.

Demographics are also characterized and identified for (1) the populations residing or working near the waste site; (2) the activity patterns of residents and/or workers; and (3) if any exist, the locations of potentially sensitive subgroups. Sources of this information include (1) site visits, (2) previous investigations, (3) information generated during the RI, (4) maps, (5) aerial and standard photographs, and (6) Navy personnel interviews. Key to this activity is determining current and foreseeable future land use of the waste site and surrounding areas (e.g., residential, commercial and industrial, or recreational). Future land use of OU 1 will be controlled in part by institutional controls associated with the presumptive remedy that is described earlier in this report.

6.1.3.2 **Identification of Exposure Pathways and Receptors** The purpose of this step in the exposure assessment is the identification of all relevant exposure pathways through which specific populations may be exposed, under current and future land use, to contaminants at the site. An exposure pathway consists of four necessary elements: a source or mechanism of chemical release, a transport or retention medium, a point of human contact, and a route of exposure at the point of contact (USEPA, 1989a). Exposure pathways that have these elements are considered complete pathways. Only complete exposure pathways are evaluated in the HHRA.

In most cases, the source of contamination is either in the soil, or soil is the initial receiving medium. There are several mechanisms for migration of contaminants from soil. Contaminants may accumulate in plants and animals that are in contact with soil or are in food chains that include biota in direct contact with soil. Mechanisms for migration into air include volatilization (primarily VOCs) and wind erosion of contaminated soil (all types of contaminants). Overland flow of water can result in migration of contaminants to surface water and sediment and in relocation to other surface soil (all types of contaminants). Infiltration can result in migration into subsurface soil and into groundwater (soluble contaminants). Contaminants can be transported in groundwater (primarily soluble VOCs, SVOCs, and inorganics) and may potentially also discharge to surface water. Analytes can also be transferred to sediment (generally insoluble forms of inorganics and relatively insoluble SVOCs and pesticides) and to fish (primarily nonpolar organics and some inorganics that tend to accumulate in tissue) and other biota.

Human receptors are identified based on the current and potential future land uses. Receptors commonly include future residents (when reasonably expected) and excavation workers and current site workers and trespassers. Exposure scenarios are constructed to evaluate each receptor (Paragraph 6.1.3.3). Medium-specific receptors and exposure scenarios have been identified for current and future land use as described below. This information is also summarized in Table 6-5 and Figure 6-1.

Surface Soil. The evaluation of risks associated with surface soil exposures is conducted here to determine if a cap is required as part of a presumptive remedy for municipal landfills. Under a presumptive remedy scenario, it is not necessary to conduct a risk assessment for potential exposure to soils which will be covered by a cap. If, however, risks associated with surface soil exposures are insignificant and there are no concerns about leaching of contaminants from the landfill into groundwater, a cap may not be necessary as part of the presumptive remedy. In some cases where a presumptive remedy is being considered, risks associated with all media may be insignificant and no remedy may be required. The surface soil risk evaluation shown here was conducted to provide information concerning the need for a cap.

The North Grinder Landfill area is currently used as a parade ground. Much of the area of the former landfill is covered with asphalt pavement. Although permission is required to obtain access to NTC, Orlando, the North Grinder Landfill and the surrounding area are accessible to Navy personnel and their adult and child dependents. Currently, adult and adolescent trespassers could be exposed to contaminants in surface soil outside the boundaries of the paved area; therefore, exposure of these receptors (ingestion of and direct contact with surface soil and inhalation of particulates from surface soil) is evaluated in the HHRA. Much of the North Grinder Landfill area is paved; therefore, it is unlikely that occupational and site maintenance workers are currently exposed to contaminants in surface soil.

No humans currently reside at the North Grinder Landfill. A deed restriction will prevent conversion of the North Grinder Landfill area to residential use. Therefore, exposure of theoretical future residents to contaminants in surface soil is not evaluated in the HHRA.

If the North Grinder Landfill is developed for industrial use in the future, occupational workers and excavation workers could be exposed to contaminants in surface soil. Therefore, potential exposure of these receptors to contaminants in surface soil is evaluated in the HHRA. In addition, should the area be converted to recreational use (such as ball fields), older child and adult receptors could be exposed to contaminants on surface soil (or existing landfill cover if the pavement were removed and not replaced). Therefore, potential exposure of these receptors is evaluated in the HHRA.

Groundwater. Currently, humans do not reside at the North Grinder Landfill, and groundwater is not used for any potable or nonpotable purpose. The North Grinder

Table 6-5
Summary of Potential Human Exposure Pathways

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Medium of Exposure	Route of Exposure	Potentially Exposed Population	Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Use				
Surface Soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Resident (child and adult) Trespasser (adolescent and adult) Occupational worker (adult) Site maintenance worker (adult) Excavation worker (adult)	No Yes No No No	No humans currently reside at the North Grinder Landfill. Adolescents and adults may be exposed to contaminants in the surface soil while trespassing. Most of the North Grinder Landfill Area is paved; therefore, it is unlikely that occupational and site maintenance workers will be exposed to contaminants in surface soil. No excavation work is anticipated under current land use.
Subsurface Soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Excavation worker (adult)	No	No subsurface soil has been sampled.
Groundwater	Ingestion of groundwater as drinking water and inhalation of volatiles while showering.	Resident (adult)	No	There are no current exposures to groundwater.
Surface Water	Dermal contact with surface water and ingestion of surface water while wading.	Resident (child and adult) Trespasser (adolescent and adult)	No No	No surface water present.
Sediment	Dermal contact with sediment and ingestion of sediment.	Resident (child and adult) Trespasser (adolescent and adult)	No No	No sediment present.
Future Land Use				
Surface Soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Resident (child and adult) Recreational user (adolescent and adult) Occupational worker (adult) Site maintenance worker (adult) Excavation worker (adult)	No Yes Yes Yes Yes	The North Grinder Landfill will not be developed for residential use. If the North Grinder Landfill area were developed for industrial use, occupational and site maintenance workers may be exposed to contaminants in surface soil. Excavation workers could also be exposed to contaminants in surface soil; if the area were converted to recreational use, adolescents and adults could be exposed.

Table continued on next page.

Table 6-5 (Continued)
Summary of Potential Human Exposure Pathways

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Medium of Exposure	Route of Exposure	Potentially Exposed Population	Selected for Evaluation?	Reason for Selection or Exclusion
Future Land Use (Continued)				
Subsurface Soil	Dermal contact with soil, ingestion of soil, and inhalation of fugitive dust.	Excavation worker (adult)	No	No subsurface soil was sampled.
Groundwater	Ingestion of groundwater as drinking water and inhalation of volatiles while showering	Resident (adult)	No	The North Grinder Landfill will not be developed for residential use. Wells for any use will not be installed in the area. There is no migration of contamination via groundwater.
Surface Water	Dermal contact with surface water and ingestion of surface water while wading.	Resident (child and adult) Trespasser (adolescent and adult)	No No	No surface water present.
Sediment	Dermal contact with sediment and ingestion of sediment.	Resident (child and adult) Trespasser (adolescent and adult)	No No	No sediment present.

Landfill area will not be developed for residential use, and a deed restriction will prevent the installation of wells in the North Grinder Landfill area for potable or nonpotable use of the groundwater. There is no indication that any migration of contamination to offsite areas has occurred or is likely to occur in the future. Therefore, there are no complete exposure pathways for groundwater. No further exposure assessment or risk characterization is conducted for groundwater at the North Grinder Landfill.

Surface Water. There is no surface water associated with the North Grinder Landfill.

Sediment. There is no sediment associated with the North Grinder Landfill.

6.1.3.3 Quantification of Exposures Once complete exposure pathways are selected for evaluation (Paragraph 6.1.3.2), the final step of the exposure assessment is to quantify exposure (i.e., intake) for each pathway. This quantification process involves developing assumptions regarding exposure conditions and exposure scenarios for each receptor to estimate the total amount of contaminants that a hypothetical receptor may ingest, dermally absorb, or inhale from each exposure pathway. These exposure scenarios are based on several variables, which can be grouped into chemical-, population-, and assessment-related variables.

The ultimate goal of this step, as defined in USEPA guidance, is to identify the combination of these exposure variables or parameters that results in the most intense level of exposure that may "reasonably" be expected to occur under current and future site conditions (USEPA, 1989a). This is performed for every complete exposure pathway selected for evaluation. The resulting exposure scenarios are referred to as the reasonable maximum exposure (RME) for each exposure pathway. More recent USEPA guidance (USEPA, 1992c) recommends developing two exposure scenarios, an average exposure and a "high end," or RME. This guidance also suggests that other uncertainty analyses, including Monte Carlo analysis, can be useful in putting risk estimates into perspective.

Chemical-Related Variable. The chemical-related variable is the exposure point concentration (EPC), which is the representative concentration at the exposure point. The EPCs are calculated in a manner consistent with USEPA guidance (USEPA, 1989a; 1992c; 1992d). The EPCs are, with the exceptions noted below, the 95 percent upper confidence limit (UCL) on the arithmetic mean of the concentrations in the data set used to evaluate exposure. The following equation for calculating the UCL on the arithmetic mean for a lognormal distribution (USEPA, 1991a; 1992d) is used to calculate all UCLs:

$$UCL = e^{\left(\overline{x} + 0.5\, s^2 + \frac{s\,H}{\sqrt{n-1}} \right)} \qquad (2)$$

where:

UCL = upper confidence limit,
e = constant (base of the natural log, equal to 2.718),
xbar = mean of transformed data,
s = standard deviation of the transformed data,

H = H-statistic (from table published in Gilbert, 1987), and
n = number of samples.

In calculating the 95 percent UCLs, nondetects are assigned a value of one-half the associated reporting limits in the calculation of the arithmetic mean. In cases where there are fewer than four samples or where the UCL is greater than the maximum detected concentration, the maximum detected concentration is identified as the EPC.

EPCs for surface soil were determined as described above. The EPCs for analytes selected as HHCPCs for surface soil are presented in Table 6-6.

Population-Related Variables. Population-related variables describe the characteristics of a hypothetical individual receptor within each potentially exposed population. These variables include contact rates, such as exposure frequencies and ingestion rates, and physical characteristics of human bodies, such as body weights and surface areas. When applicable, contact rates are selected from USEPA standard default exposure factor guidance (USEPA, 1991a) or USEPA dermal guidance (USEPA, 1992b). If site-specific factors indicate that such parameters are not appropriate, alternative parameters are used based on knowledge of human behavior and the relative accessibility of a site. Parameters describing the physical characteristics of the exposed populations are identified from appropriate USEPA guidance (USEPA, 1989a; 1989b; 1991a) and are presented in Appendix J-4.

Assessment-Related Variable. The assessment-related variable involved in exposure quantification is the averaging time. Averaging time reflects the duration of exposure and depends on the type of effect being evaluated. Exposure intake during a defined interval (e.g., a lifetime) is averaged over the entire period, resulting in an estimate of average daily intake.

There are essentially two types of effects typically evaluated in human health risk assessment: carcinogenic effects and noncarcinogenic effects. According to USEPA guidance, the averaging time for carcinogenic effects is assumed to be a 70-year lifetime (USEPA, 1989a). The averaging times for noncarcinogenic effects are equivalent to the duration of exposure and may vary depending on the nature of exposure. There is a wide range of possible estimates, from a day to a lifetime. However, based on USEPA guidance, exposure duration for noncarcinogenic effects can roughly be categorized into one of three periods: (1) chronic exposures, 7 years to a lifetime; (2) subchronic exposures, 2 weeks to 7 years; and (3) acute exposures, less than 2 weeks (USEPA, 1989a). The length of the exposure period depends on the potentially exposed population and the characteristics of exposure. The averaging times applied to receptors are used in the risk calculations. All exposure scenarios evaluated for noncarcinogenic effects at NTC, Orlando are considered chronic or subchronic exposures.

Calculation of Intakes. The equations used to calculate chemical intake are those presented in USEPA guidance (USEPA, 1989a). The general equation for

Table 6-6
Exposure Point Concentrations for Human Health Chemicals of Potential Concern

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Chemical	Frequency of Detection[1]	Maximum Detected Concentration	95% UCL[2]	Exposure Point Concentration[3]
Semivolatile Organic Compounds (μg/kg)				
Benzo(a)anthracene	3/14	480	224	224
Benzo(a)pyrene	3/14	1,200	340	340
Benzo(b)fluoranthene	2/14	410	217	217
Benzo(k)fluoranthene	3/14	4,000	602	602
Chrysene	3/14	500	240	240
Dibenz(a,h)anthracene	2/14	760	257	257
Indeno(1,2,3-cd)pyrene	3/14	2,300	428	428
Pesticides and PCBs (μg/kg)				
Dieldrin	7/14	175	196	175
gamma-BHC (Lindane)	1/14	1.025	1.4	1.025
Aroclor-1260	6/14	150	78.3	78.3
Inorganics Analytes (mg/kg)				
Arsenic	10/14	2.7	2.1	2.1

[1] Frequency of detection is the number of samples in which the analyte was detected divided by the number of samples analyzed.
[2] The 95 percent UCL is calculated on the arithmetic mean of all samples using one-half the contract-required quantitation limit or contract-required detection limit for nondetected concentrations.
[3] The exposure point concentration equals the 95 percent UCL unless the maximum detected concentration is less than the 95 percent UCL. If there are nine or less total samples, the maximum detected concentration is the exposure point concentration.

Notes: % = percent.
UCL = upper confidence limit.
μg/kg = micrograms per kilogram.
PCBs = polychlorinated biphenyls.
mg/kg = milligrams per kilogram.

calculating chemical intake is as follows:

$$Intake = \frac{C \times CR \times EF \times ED}{BW \times AT} \tag{3}$$

where:

Intake	=	daily chemical intake per unit body weight averaged over the exposure period,
C	=	concentration of the chemical in the exposure medium,
CR	=	contact rate for the medium of concern,
EF	=	exposure frequency,
ED	=	exposure duration,
BW	=	body weight of the hypothetically exposed individual,
AT	=	averaging time (for carcinogens, AT = 70 years for 365 days per year; for noncarcinogens, AT = ED).

The contaminant exposure intakes for the receptors that were evaluated are presented in the risk calculation spreadsheets in Appendix J-5.

Some of the exposure pathways require additional calculations before intake values can be calculated. Brief explanations of the additional calculations required for the inhalation of particulates, inhalation of vapors while showering, and dermal absorption are provided below.

Inhalation of Particulates from Soil. This evaluation is conducted to estimate levels of site contaminants that could occur in ambient air as a result of wind erosion. To estimate atmospheric concentrations of fugitive air contaminants, a three-step modeling process is conducted. In the first step, respirable particle-phase emission rates are calculated. In the second step, contaminant emission rates on a unit surface area basis are calculated. In the third step, downwind ambient concentrations are estimated using air dispersion modeling. The three-step process is further defined in Appendix J-6.

Dermal Absorption from Soil. Dermal absorption from soil is calculated in accordance with the USEPA *Dermal Exposure Assessment: Principles and Applications*, Interim Report (USEPA, 1992b). Percutaneous absorption of chemicals detected in soil is chemical and matrix dependent. According to USEPA Region IV guidance (USEPA, 1995a), absorption factors for organics and inorganics are 0.1 percent and 0.01 percent, respectively. A soil adherence factor of 1 milligram of soil per square centimeter of skin (mg/cm^2) per event is used in the dermal intake equations (USEPA, 1992b). The equations used to describe dermal absorption from soil are located in Appendix J-7.

Receptor-specific exposure parameters for each exposure scenario are presented in Appendix J-4. The risk calculation spreadsheets in Appendix J-5 to this report also contain the exposure parameters for each exposure scenario.

6.1.4 Toxicity Assessment The purpose of the toxicity assessment is to identify the adverse effects that are associated with exposure to each HHCPC and to identify the relationship between the level of exposure and the severity or likelihood of adverse effects. The toxicity assessment evaluates the available evidence on the potential adverse effects associated with exposure to each HHCPC. With this information, a relationship between the extent of exposure and the likelihood or severity of adverse human health effects is developed. Two steps are typically associated with toxicity assessment: hazard identification and dose-response assessment.

6.1.4.1 Hazard Identification Hazard identification is the process of determining if exposure to an agent can cause a particular adverse health effect and, more importantly, if that effect will occur in humans. Characterizing the nature and strength of causation is a part of the hazard identification step. For a number of the chemicals at hazardous waste sites, potential toxic effects have already been identified. Consequently, the objectives of the hazard identification in the HHRA are to (1) identify which of the contaminants detected at the site are potential hazards, and (2) summarize their potential toxicity in brief narrative profiles.

6.1.4.2 Dose-Response Assessment A dose-response assessment is conducted to characterize and quantify the relationship between intake, or dose, of an HHCPC and the likelihood of a toxic effect, or response. There are two major types of toxic effects evaluated in an HHRA: carcinogenic and noncarcinogenic. Following USEPA guidance for HHRAs (USEPA, 1989a), these two endpoints (cancer and noncancer) are evaluated separately. As a result of the dose-response assessment, identified dose-response values are used to estimate the incidence of adverse effects as a function of human exposure to a chemical.

There are two types of dose-response values: cancer slope factors (CSFs) for carcinogens and reference doses (RfDs) for noncarcinogens. For many compounds, both types of values have been developed by USEPA because many compounds cause both carcinogenic and noncarcinogenic effects. In addition, because the toxicity and/or carcinogenicity of a compound can depend on the route of exposure (i.e., oral, inhalation, or dermal), unique dose-response values are developed for the oral, dermal, and inhalation exposure routes. The source of the dose-response values is described below. All dose-response values for analytes evaluated in this risk assessment are presented in Appendix J-8.

<u>Cancer Toxicity Values</u>. The CSF is a chemical-specific toxicity value developed by the USEPA Carcinogenic Assessment Group (CAG) based upon the dose of a chemical and the probability of a carcinogenic response. The unit risk, a toxicity value developed by the USEPA, is an estimate of the relationship between the inhaled concentration of a chemical and the probability of a carcinogenic response from the exposure during the lifetime of the individual.

As required by USEPA Region IV guidance (USEPA, 1995a), risks associated with dermal exposures (most commonly for soil and water dermal contact) are evaluated using CSFs that are specific to dermally absorbed doses. Most oral CSFs are based on administered dose rather than the absorbed dose (trichloroethene's CSF is a notable exception). It is, therefore, necessary to adjust toxicity values that are based on administered doses so that they can be used for evaluation of absorbed doses. For dermal exposures, the toxicity values are adjusted as follows:

$$CSF_{adjusted} = \frac{CSF_{oral}}{ABSEFF_{oral}} \tag{4}$$

where $ABSEFF_{oral}$ is the absorption efficiency in the study that is the basis of the oral toxicity value.

If there is no information available on oral absorption efficiency, the conservative default values (USEPA, 1995a) of 80 percent for volatiles, 50 percent for SVOCs, and 20 percent for inorganics are used.

The oral CSF, inhalation CSF and unit risk, dermal CSF, weight of evidence classification, and cancer type observed for each carcinogenic HHCPC analyzed in an HHRA are provided in Appendix J-8.

<u>Noncancer Toxicity Values</u>. The RfD is an estimate (with uncertainty spanning an order of magnitude or more) of a daily intake for the human population, including sensitive subpopulations, that is likely to be without appreciable risk of deleterious effects during a lifetime. Noncarcinogenic risks due to inhalation are estimated by comparing the inhalation concentration to the inhalation correlate of the RfD, the reference concentration (RfC).

As required by USEPA Region IV guidance (USEPA, 1995a), risks associated with dermal exposures (most commonly for soil and water dermal contact) are evaluated using RfDs that are specific to absorbed doses. Most oral RfDs are based on an administered dose rather on the absorbed dose. It is, therefore, necessary to adjust toxicity values that are based on administered doses so that they can be used for evaluation of absorbed doses. For dermal exposures, we adjust the toxicity values as follows:

$$RfD_{adjusted} = RfD_{oral} \times ABSEFF_{oral} \tag{5}$$

where $ABSEFF_{oral}$ is the absorption efficiency in the study that is the basis of the oral toxicity value.

If there is no information available on oral absorption efficiency, the conservative default values (USEPA, 1995a) of 80 percent for volatiles, 50 percent for SVOCs, and 20 percent for inorganics are used.

Separate sets of RfDs have been developed for several chemicals for evaluating chronic and subchronic exposures. When available, subchronic RfDs are used for evaluating exposures with a duration less than 7 years but more than 2 weeks. Chronic RfDs are used when subchronic values are unavailable and when the exposure duration is greater than 7 years. There are no analogous reference values for evaluating acute exposures, those lasting less than 2 weeks.

The oral RfD, inhalation RfC, dermal RfD, critical study on which the RfD is based, critical effect in the study, any uncertainty and modifying factors applied to the RfD or RfC, and the degree of confidence assigned to the RfD or RfC for each HHCPC analyzed in the HHRA are provided in an Appendix J-8.

6.1.4.3 Source of Dose-Response Values The primary source for identifying dose-response values is the USEPA Integrated Risk Information System (IRIS), which is an on-line database containing health risk and USEPA regulatory information about specific chemicals (USEPA, 1996). Health risk information is included on IRIS only after a comprehensive review of chronic toxicity data by work groups composed of USEPA scientists. If no information is found in IRIS, the USEPA Health Effects Assessment Summary Tables (HEAST) (USEPA, 1995d; 1995e) are used as a source of information. If appropriate dose-response values are not located from either of these two sources, other USEPA sources (including past versions of IRIS and HEAST and the documents produced by the USEPA's National Center for Environmental Assessment (formerly the Environmental Criteria and Assessment Office) are consulted. If no USEPA dose-response value is identified, surrogate values from structurally similar compounds may be assigned.

Dose-response values for each of the contaminants selected as an HHCPC in an HHRA are provided in Appendix J-8. Toxicity profiles for HHCPCs are presented in Appendix J-9.

6.1.4.4 Toxicity Equivalency Factors for Carcinogenic PAHs Carcinogenic PAHs are a class of compounds with very similar, complex heterocyclic structures. From this group of compounds, only one, benzo(a)pyrene, has a USEPA-published CSF. For the other carcinogenic PAHs, the variable toxicity has been addressed by using Toxicity Equivalency Factors (TEFs) published by USEPA (USEPA, 1993a). The TEFs identify the relative potency of each compound relative to that of benzo(a)pyrene.

The TEFs are not CSFs themselves nor are they used to calculate CSFs for the other PAHs. The TEFs are applied to carcinogenic PAH EPCs to determine the equivalent benzo(a)pyrene concentration. The benzo(a)pyrene equivalent EPC for each carcinogenic PAH is then multiplied by the CSF for benzo(a)pyrene to obtain an estimate of the cancer risk for these compounds. The TEFs are only used in estimating the cancer risk of these compounds and are not used to estimate the noncancer risks. The TEFs for the carcinogenic PAHs are provided in Table 6-7.

6.1.5 Risk Characterization Risk characterization is the final step in the risk assessment process. This step involves the integration of the exposure and toxicity assessments into a qualitative or quantitative expression of potential human health risks associated with contaminant exposure. Quantitative estimates of both carcinogenic and noncarcinogenic risks are made for each HHCPC and each complete exposure pathway identified in the exposure assessment.

Carcinogenic Risks. Carcinogenic risks associated with exposure to individual chemicals are estimated by multiplying the chemical intake for each carcinogen by its CSF. This value is a chemical-specific excess lifetime cancer risk (ELCR) and represents an upper bound of the probability of an individual developing cancer over a lifetime as the result of exposure to a chemical. For each exposure pathway, the chemical-specific risks for all carcinogenic compounds are summed to determine the pathway-specific lifetime cancer risk. The following equations are used to estimate the chemical- and pathway-specific cancer risks:

Chemical-Specific Excess Lifetime Cancer Risk

$$Risk_i = CDI_i \times CSF_i \tag{6}$$

where:

$Risk_i$ = unitless probability of an individual developing cancer as the result of exposure to a chemical i,

Table 6-7
Toxicity Equivalency Factors for Carcinogenic Polynuclear Aromatic Hydrocarbons

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Polynuclear Aromatic Hydrocarbon	Toxicity Equivalency Factors
Benzo(a)pyrene	1
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenzo(a,h)anthracene	1
Indeno(1,2,3-c,d)pyrene	0.1

Source: U.S. Environmental Protection Agency (USEPA, 1993a).

CDI_i = chronic daily intake of chemical i averaged over 70 years and expressed as milligrams per kilogram body weight per day (mg/kg-day), and

CSF_i = USEPA cancer slope factor for chemical i $(mg/kg\text{-}day)^{-1}$.

Pathway-Specific Incremental Lifetime Cancer Risk

$$Risk_T = \Sigma\, Risk_i \tag{7}$$

where

$Risk_T$ = unitless probability of an individual developing cancer as the result of multiple chemical exposures and

$Risk_i$ = unitless cancer risk estimate for the i^{th} chemical associated with an exposure pathway.

The results from the carcinogenic risk assessment are compared with acceptable risks established by the USEPA. The USEPA guidelines, established in the National Oil and Hazardous Substances Contingency Plan (NCP), indicate that the total lifetime cancer risk due to exposure to the HHCPCs at a site, by each complete exposure pathway, should not exceed a range of 1 in 1,000,000 ($1x10^{-6}$) to 1 in 10,000 ($1x10^{-4}$) (USEPA, 1990a). FDEP has indicated that 10^{-6} is its cancer risk level of concern. For reference, the average cancer burden in the United States in 1993 was 1 in 3 for women and 1 in 2 for men (American Cancer Society, 1994).

Noncarcinogenic Risks. Noncarcinogenic risk estimates are calculated by dividing chemical intake for each compound by the appropriate RfD. The result is called the hazard quotient (HQ). The HQs for individual compounds within an exposure pathway were summed to obtain the hazard index (HI) for that particular pathway.

The following equations are used to determine the HQs and HIs:

Hazard Quotient

$$HQ_i = \frac{I_i}{RfD_i} \tag{8}$$

where

HQ_i = hazard quotient of chemical i,

I_i = intake of chemical i averaged over the exposure period (mg/kg-day), and

RfDi = reference dose for chemical i corresponding to the same exposure duration as the intake (mg/kg-day).

Hazard Index

$$HI = \Sigma\, HQ_i \tag{9}$$

where

HI = potential for noncarcinogenic effects from multiple chemical exposures and

HQi = hazard quotient for i^{th} chemical associated with an exposure pathway.

HQ less than 1 indicates that noncarcinogenic toxic effects are not expected to occur due to HHCPC exposure. HIs greater than 1 may be indicative of a possible noncarcinogenic toxic effect but the circumstances must be evaluated on a case-by-case basis (USEPA, 1989a). As the HI increases, so does the likelihood that adverse effects might be associated with exposure. In general, chronic HI values are calculated.

6.1.5.1 Summary Risk estimates are calculated for each exposure pathway and receptor at OU 1, and they are summarized in Table 6-8. The risks are presented by medium for both current and future land uses. The calculations of these estimates are documented in an appendix with all spreadsheets used to complete calculations. Within the risk summary text for each medium and site, the relative confidence in each risk estimate is discussed. The relative significance of risk estimates is evaluated in terms of a comparison with acceptable risk limits established by USEPA and the State and by comparison of site concentrations to ARARs and Florida soil cleanup goals.

Both carcinogenic and noncarcinogenic risks were estimated for each HHCPC and each complete exposure pathway selected for evaluation in the exposure assessment. Risk calculations are documented in the spreadsheets in Appendix J-5. Risk estimates for potential exposures to surface soil under current and future land use scenarios are discussed in Paragraphs 6.1.5.1 and 6.1.5.2, respectively. Table 6-7 presents a summary of the risk estimates.

6.1.5.2 Surface Soil Current Land Use The risk characterization results for current land use surface soil exposure scenarios are shown in Tables J-5.1 through J-5.4 in Appendix J-5 to this report and are summarized in Table 6-7. For the current land use trespasser scenario (which presumes the pavement has been removed), estimated cancer risks are within the USEPA Superfund risk range, and the noncancer HI for the child and adult trespasser are both well below 1, which is considered an allowable risk level.

For the current land-use trespasser scenario, only one compound, Dieldrin, is associated with cancer risk greater than 10^{-6}, which is the stated FDEP risk level of concern. The estimated risk of 2 x 10^{-6} is associated with dermal soil contact (1.2 x 10^{-6}) and incidental ingestion (6 x 10^{-7}). The risk estimate is based on the maximum reported concentration of Dieldrin (175 μg/kg). The mean of detected Dieldrin concentrations is 56 μg/kg, which is below the residential and industrial cleanup goals for Florida, which are 70 μg/kg and 300 μg/kg, respectively. Therefore, risks associated with surface soil exposure under current land use are within acceptable limits.

6.1.5.3 Surface Soil Future Land Use The risk characterization results for future land-use potential surface soil exposure scenarios are shown in Tables J-5.5 through J-5.12 in Appendix J-5 to this report and are summarized in Table 6-7. For potential future land uses, estimated cancer and noncancer risks for the recreational user (child and adult), onsite worker, and an excavation worker are within acceptable ranges specified for the USEPA Superfund program. Estimated cancer risks for the recreational user, site worker, and the excavation worker are $2x10^{-6}$, $6x10^{-6}$, and $1x10^{-7}$, respectively. Calculated HI values for the same receptors are 0.02, 0.02, and 0.009, all well below 1, which is considered an allowable level.

Table 6-8
Human Risk Summary for the North Grinder Landfill

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Land Use	Exposure Route	Hazard Index	Excess Lifetime Cancer Risk
Current Land Use			
Surface Soil			
Adolescent trespasser	Incidental ingestion	0.01	1×10^{-6}
	Dermal contact	0.003	4×10^{-7}
	Inhalation of particulates	NC	5×10^{-10}
	Total adolescent trespasser:	0.01	1×10^{-6}
Adult trespasser	Incidental ingestion	0.001	1×10^{-6}
	Dermal contact	0.006	1×10^{-6}
	Inhalation of particulates	NC	2×10^{-8}
	Total adult trespasser:	0.002	2×10^{-6}
	Total trespasser:	NC	3×10^{-6}
Future Land Use			
Surface Soil			
Recreational Child	Incidental ingestion	0.01	1×10^{-6}
	Dermal contact	0.003	4×10^{-7}
	Inhalation of particulates	NC	5×10^{-10}
	Total recreational child :	0.01	1×10^{-6}
Recreational Adult	Incidental ingestion	0.006	1×10^{-6}
	Dermal contact	0.002	6×10^{-7}
	Inhalation of particulates	NC	2×10^{-8}
	Total recreational adult :	0.02	2×10^{-6}
	Total recreational receptor:		3×10^{-6}
Surface Soil			
Site worker	Incidental ingestion	0.01	4×10^{-6}
	Dermal contact	0.005	2×10^{-6}
	Inhalation of particulates	NC	5×10^{-8}
	Total site worker:	0.02	6×10^{-6}
Future Land Use			
Surface Soil			
Excavation Worker	Incidental ingestion	0.008	9×10^{-8}
	Dermal contact	0.0006	1×10^{-8}
	Inhalation of particulates	NC	7×10^{-8}
	Total excavation worker:	0.009	1×10^{-7}

[1] A hazard index could not be calculated for inhalation exposures because inhalation reference doses were not available for the HHCPCs.

Notes: NC = not calculated.
HHCPC = human health chemical of potential concern.

For the recreational user, only Dieldrin has an estimated cancer risk greater than 10^{-6}, which is the FDEP's stated risk level of concern. The estimated risk of $2x10^{-6}$ is associated with dermal soil contact ($1.2x10^{-6}$) and incidental ingestion ($6x10^{-7}$). The risk estimate is based on the maximum reported concentration of Dieldrin (175 μg/kg). The mean of detected Dieldrin concentrations is 56 μg/kg, which is below the industrial cleanup goal for Florida, which is 300 μg/kg. With a deed restriction prohibiting residential use, the Dieldrin concentrations would be consistent with the Florida cleanup goals.

For the potential future site worker, cancer risks associated with benzo(a)pyrene ($1.4x10^{-6}$), dibenz(a,h)anthracene ($1.1x10^{-6}$), Dieldrin ($1.7x10^{-6}$) and arsenic ($1.2x10^{-6}$) slightly exceed 10^{-6}, which is the stated FDEP risk level of concern. However, the EPCs for each of these four analytes is less than the corresponding industrial cleanup goals for Florida: benzo(a)pyrene EPC of 340 μg/kg versus a cleanup goal of 500 μg/kg; dibenz(a,h)anthracene EPC of 257 μg/kg versus a cleanup goal of 500 μg/kg; Dieldrin EPC of 175 μg/kg versus a cleanup goal of 300 μg/kg; and arsenic EPC of 2.1 mg/kg versus a cleanup goal of 3.1 mg/kg. With deed restrictions that prevent residential use of the property, risks meet the USEPA risk limits, and site concentrations are consistent with industrial cleanup goals for Florida.

6.1.6 Uncertainty Analysis Risk estimates are generally conservative values that result from multiple layers of conservative assumptions inherent in the risk assessment process. Quantitative estimates of risk are based on numerous assumptions, most intended to be protective of human health (i.e., conservative). As such, risk estimates are not truly probabilistic estimates of risk, but rather conditional estimates given a series of conservative assumptions about exposure and toxicity.

A thorough discussion of all potential sources of uncertainty in risk assessment is not feasible. In general, sources of uncertainty can be categorized into site-specific factors (e.g., variability in analytical data and exposure assessment) and toxicity and risk characterization assessment factors. Most toxicity- and risk characterization-specific uncertainties apply to all HHRAs equally in their impact on the calculated risk estimates. Common (not site-specific) sources of uncertainty and their potential effects on the magnitude of estimated risks are discussed here. Table 6-9 summarizes some of the sources of uncertainty that are common to all HHRAs. Site-specific uncertainties are normally discussed in the site-specific uncertainty section in an HHRA to provide perspective for the interpretation of the site-specific risk estimates.

Data Collection, Analysis, and Evaluation. A certain amount of uncertainty is associated with the representative nature of the data collected to complete the risk evaluation at each site. Additional uncertainties associated with estimating exposure result from the variance in sampling and analytical techniques. There are three general uncertainties related to data collection, analysis, and evaluation:

- nature and extent of contamination,
- adequate characterization of exposure areas, and

Table 6-9
Potential Sources of Uncertainty

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Potential Source	Direction of Effect	Justification
Exposure Assessment		
Likelihood of exposure pathways	Overestimate	Actual exposure may not occur
Exposure point concentrations	Unknown	Sampling data are assumed to be representative of the exposures.
Exposure assumptions (e.g., frequency)	Overestimate	Parameters selected are conservative estimates of exposure representing a reasonable maximum exposure.
Degradation of chemicals not considered	Overestimate	Risk estimates are based on recent chemical concentrations. Concentrations tend to decrease over time as a result of degradation for many organics.
Absorption of soil contaminants through the skin	Overestimate	Dermal absorption of chemicals is a function of the length of actual skin contact. Contact may be insufficient to result in the absorption assumed.
Modeled exposure point concentrations	Unknown, probably overestimate.	Models are based on numerous assumptions resulting in conservative exposure point concentrations (EPCs).
Toxicity Assessment		
Extrapolation of animal toxicity data to humans	Unknown, probably overestimate.	Animals and humans differ with respect to adsorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference varies with each chemical. Animal studies typically involve high-dose exposures, whereas humans are exposed to low doses.
Use of linearized, multi-stage model to derive cancer slope factors	Overestimate	Model assumes a nonthreshold, linear at low dose relationship for carcinogens. Many compounds induce cancer by non-genotoxic mechanisms. Model results in 95 percent upper confidence limits of cancer potency. Potency is unlikely to be higher and may be as low as zero.
Lack of oral toxicity values for lead	Underestimate	Dose-response values for lead are not available for exposures to lead in soil or groundwater. Risk from exposure to lead in soil and groundwater is not quantitatively evaluated.
Lack of inhalation toxicity values	Underestimate	Inhalation reference doses (RfDs) and cancer slope factors (CSFs) will not be available for all human health chemicals of potential concern (HHCPCs) being evaluated for inhalation exposures (fugitive dust and volatiles while showering). Therefore, risks cannot be quantified and are underestimated.
Risk Characterization		
Summation of risk among chemicals within exposure pathways	Unknown	Little is known about the toxicity of chemical mixtures. In the absence of evidence to the contrary, additivity of risk is assumed.

- differences between site-specific inorganic concentrations and background inorganic concentrations.

Nature and Extent of Contamination. The nature and extent of contamination is normally discussed in detail as part of the RI. The extensive sampling and analytical program of an RI should adequately characterize the types of contaminants present, the physical location of those contaminants, and the concentrations that are present. There is inherent uncertainty in the assumption that the nature and extent of contamination has been adequately characterized.

Adequate Characterization of Exposure Areas. Contaminated areas, specifically soil, are sometimes small relative to the area in which a receptor would potentially be exposed. Nonrandom sampling may be conducted in areas of known or visible contamination. Because a receptor's exposure area may actually be larger than the area of contamination and a receptor's exposure would often be random, the nonrandom sampling may actually result in overestimation of exposures.

Differences between Site and Background Concentrations. A comparison between site-specific and background inorganic concentrations is conducted as part of the selection of HHCPCs (Subsection 6.1.2). Both organic contaminants and inorganic analytes are commonly detected in surface soil and groundwater background locations.

Organics (e.g., pesticides) that are sometimes detected in background samples, which would be expected in an industrialized area such as NTC, Orlando, do not necessarily indicate that the inorganic concentrations in those samples do not represent background reference concentrations. Phthalates are also commonly detected in background samples. Phthalates are common sampling and laboratory contaminants, but sometimes cannot be conclusively associated with laboratory or sampling contamination and, therefore, are retained in the background data set. In summary, the presence of organic contamination in a particular background location does not necessarily indicate that the inorganic concentrations in that sample is not representative of inorganic reference concentrations. The use of the background sample data as a reference point for inorganics detected in surface soil and groundwater is generally considered appropriate based on carefully chosen sampling locations.

Selection of Chemicals of Potential Concern. Although a USEPA approach is that criteria are used in selecting HHCPCs (USEPA, 1989a), there are uncertainties in the general selection process based on the use of a risk-based screening and comparison to inorganic concentrations at reference locations.

USEPA Region III Risk-Based Screening Table (October 20, 1995). USEPA Region IV prefers to exclude contaminants that do not contribute significantly to the risk from the risk calculations (USEPA, 1995a). The HHRA uses medium-specific RBCs that are calculated by assuming residential exposures and calculating risk-based levels in water (e.g., tap water) and soil (e.g., residential surface soil) using an acceptable cancer risk level of 10^{-6} and an HQ of 0.1 (USEPA, 1995a) as a risk-based screening for the maximum concentration of each contaminant detected in surface soil and groundwater, respectively. Because residential use is not an option at OU 1 because of deed restrictions, the use of residential RBCs is a very conservative approach.

Background Screening for Inorganics. For a given inorganic analyte, the maximum reported soil or groundwater concentration at a waste site is compared to two times the average of the medium-specific concentrations in the background (Subsection 6.1.2) locations. This comparison is conducted as part of the selection of HHCPCs. If the maximum site concentration is less than two times the arithmetic mean of the inorganic reference concentrations, the analyte is considered to be consistent with background concentrations. This approach is conservative in that it is likely to identify certain analytes as being inconsistent with background (including them as HHCPCs) even though the distribution of concentrations onsite is very similar to that of the background data set. This can occur when the average inorganic screening concentration at a reference location is less than the maximum detected value at the site being investigated. For example, a site-specific inorganic could be present at a concentration greater than the corresponding screening concentration, including it as an HHCPC, but still be within the detected range of inorganic concentrations at the reference locations. This is the result of natural variability for inorganic concentrations in soil. Therefore, it is quite possible that an analyte could have a concentration distribution at a site that is identical to the distribution of concentrations for that analyte in the background data set, but also would have a maximum detected concentration that is more than twice the arithmetic mean of the concentrations in the reference data set.

Toxicity Equivalency Factors for Carcinogenic PAHs. In selecting HHCPCs (Subsection 6.1.2), the selection of a single PAH in a particular medium requires that the additional PAHs detected in that medium be retained as HHCPCs even if the PAH is less than the available risk-based screening level. This is a protective approach that is unlikely to underestimate risks.

Exposure Assessment. There are four major issues that contribute to uncertainties in the exposure assessment of most HHRAs:

- land use,
- use of the reasonable maximum exposure,
- determination of the exposure point concentration, and
- exposure parameters.

Land Use. Generally, exposure scenarios associated with future land use are difficult to predict. However, deed restrictions will prohibit future residential land use at OU 1. Therefore, the limits on future land use are more certain than in many other risk assessments.

Reasonable Maximum Exposure. The exposure assessments conducted in an HHRA can be characterized as RME. As such, the exposure estimates represent a mix of "high end" and average exposure parameter values that result in an exposure estimate that is unlikely to be exceeded in an exposed population. Because some of these parameters are functions of the behavior patterns and personal habits of the exposed populations, no one value can be assumed representative of all possible exposure conditions. Further, uncertainties (e.g., body weight, surface area, and ingestion rates) associated with assigning single exposure parameters to a heterogeneous population, which includes both men and women and the young and the old, are considered significant. However, the risk assessment incorporates assumptions or procedures that result in the estimate of an upper bound of risk. This type of exposure assessment tends to overestimate risks for the large majority of an exposed population. To address the most conservative exposure scenario available, the future resident (an RME) is normally evaluated in an HHRA.

<u>Exposure Point Concentration</u>. The EPCs used in the HHRA are the 95 percent UCL on the arithmetic mean concentration or the maximum reported concentration in a contaminated area (whichever is lower). In many cases, there is a relatively small number of samples available, and the 95 percent UCL is actually higher than the maximum detected concentration of a contaminant. In such cases, the maximum detected concentration has been used to represent the exposure concentrations. Because the cancer risks and HI calculations theoretically evaluate risks for average concentrations, the use of the 95 percent UCL or the maximum detected concentration is considered a conservative estimate of exposure and, therefore, risk.

<u>Exposure Parameters</u>. The selection and use of exposure parameters contribute to the uncertainty inherent in a risk estimate. There are several exposure parameters that impact most risk assessments as described below.

<u>Particulate Emission Factor</u>. The derivation of the particulate emission factor that is used as an exposure parameter to evaluate exposure to particulates resulting from soil suspension by wind is described in Appendix J-6. The particulate emission factor (PEF) that is used to calculate the concentration of soil particles that a receptor may inhale is the same for multiple receptors (for example, the resident and excavation worker). However, it is likely that more soil particles would be suspended in air during soil excavation activities and, therefore, that an excavation worker would be exposed to greater concentrations of HHCPCs associated with airborne soil particles than other receptors. Risk associated with inhalation exposures for the excavation worker may be underestimated in the HHRA. It is likely, however, that use of a PEF representing greater particulate concentrations would only result in additional risks of less than an order of magnitude. If risk estimates for the excavation worker are orders of magnitude below USEPA threshold ranges, the use of an excavation worker-specific PEF will not normally be evaluated.

<u>Toxicity Assessment</u>. Toxicity information for many chemicals is very limited, leading to varying degrees of uncertainty associated with calculated toxicity values obtained in IRIS or HEAST. General sources of uncertainty for calculating toxicity factors include extrapolation from animal to human populations, low to high dose extrapolation, short-term to long-term exposures, interspecies sensitivity variation, extrapolation from subchronic to chronic no observed adverse effect level (NOAEL), extrapolation from lowest observed adverse effect level (LOAEL) to NOAEL, amount of data supporting the toxicity factors (i.e., inadequate studies), consistency of different studies for the same chemical, and responses of various species to equivalent doses.

The identification of human carcinogens and noncarcinogens, based on animal data, is a primary source of uncertainty in the use of toxicity values. It is not certain that the identification of carcinogenic activity in an animal species means that carcinogenic activity in humans will occur. In some cases, the metabolic processes involved in carcinogenic activity in a particular organ in animals may not exist in humans. Available evidence indicates that there is a limited number of substances that are classified as human carcinogens (USEPA

Class A substances). The extrapolation of short-term to long-term exposures is also a component in some cases for the carcinogen dose-response values. The use of toxicity measures (e.g., RfDs and CSFs) introduces additional uncertainties. These parameters are generally based on animal studies, many of which are performed at high doses relative to the site-specific exposures that potentially could occur. These data require interpretation and/or extrapolation in the low dose area of the dose-response curve. The CSFs used in the risk assessment generally represent a "high end" estimate. The CSFs are the 95 percent UCL on the actual slope derived from the scientific data and, therefore, are likely overestimates of the potency.

Risk Characterization. A mixture of analytes is present in each medium evaluated at NTC, Orlando. The USEPA's *Guidelines for the Health Risk Assessment of Chemical Mixtures* (USEPA, 1986) states that if sufficient data are not available on the effects of the chemical mixture of concern, or a reasonably similar mixture, additivity of effects for constituents of the mixture should be assumed. This assumption, according to USEPA, is expected to yield generally neutral risk estimates (i.e., neither conservative nor lenient). More recent guidance from USEPA (USEPA, 1992c) also references the *Guidelines for the Health Risk Assessment of Chemical Mixtures*, but further states that the assumption of additivity assumes independence of action and that if this assumption is incorrect, overestimation or underestimation of the actual multiple substance risk may occur. In calculating HI values, additivity is assumed, but in some cases the analytes in a mixture have significantly different toxic mechanisms of action and impact different organs. In these cases, the overall HI likely overestimates noncancer risks.

General uncertainties associated with the collection, analysis, and evaluation of data; exposure assessment; toxicity assessment; and the risk estimation process are discussed in Subsection 6.1.5 . Site-specific uncertainties that are important for the interpretation of the calculated risk estimates for surface soil, groundwater, and sediment at the North Grinder Landfill are discussed below.

- Some uncertainty is associated with the representativeness of the groundwater data collected to complete the risk evaluation at the North Grinder Landfill. Generally, because the low-flow method was used, turbidity in the unfiltered groundwater samples was minimal. However, the analytical data from some of the unfiltered samples may indicate high inorganic concentrations as a result of suspended solids.

- The arsenic CSF is a source of uncertainty in the HHRA because concentrations of arsenic that tend to be present in surface soil and groundwater in the area surrounding NTC, Orlando are high enough to consistently cause arsenic to be a significant contributor to cancer risks. The oral CSF for inorganic arsenic is based on dose-response data for skin cancer incidence obtained by Tseng et al. (1968). Individuals in this study were exposed to high levels of inorganic arsenic in drinking water (170 micrograms per milliliter [μg/mℓ]). Arsenic exposure was approximated based on estimates of water intake. Other exposure pathways contributing to total exposure, such as ingestion of fish, livestock, and plants, were not assessed, potentially resulting in an underestimate of arsenic exposure. The oral slope factor was calculated using a model that assumes the dose-response curve is linear at low doses. Recent evidence suggests that low doses of arsenic may be largely detoxified by methylation, producing a non-linear dose-response curve (Goyer, 1991). In the Tseng et al. study, the normal detoxification pathways were probably overwhelmed; this, coupled with an underestimate of exposure, may have resulted in an overestimate of cancer risk. Therefore, cancer risk for the North Grinder Landfill may be overestimated. Based on the uncertainties associated with the arsenic CSF, risk management guidance (USEPA, 1988b) suggests that cancer risk may be up to tenfold lower than predicted.

__6.1.7 Remedial Goal Options (RGOs)__ Those media with estimated incremental lifetime cancer risks above 1 in 10,000 or with a total HI greater than 1 are identified for OU 1. These media are to be selected for development of media cleanup levels in accordance with USEPA Region IV guidance (USEPA, 1995a). RGOs and available criteria are intended to provide the basis for the development of remedial alternatives in the FS, which follows the RI.

The risks associated with surface soil did not exceed USEPA's risk criteria, although they did exceed the FDEP risk criteria. RGOs are presented in Table 6-10 for benzo(a)pyrene, dibenz(a,h)anthracene, Dieldrin, indeno(1,2,3-cd)pyrene and arsenic.

Table 6-10
Summary of Remedial Goal Options for Surface Soil

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Analyte	Range of Detected Concentrations	Exposure Point Concentration	Total Excess Lifetime Cancer Risk (Based on Site Worker)			Total Hazard Index (Based on to Site Worker)			Florida Soil Cleanup Goals[1]	Florida Leaching Value	Background Screening Concentration
			10^{-4}	10^{-5}	10^{-6}	3	1	0.1			
Semivolatile Organic Compounds (μg/kg)											
Benzo(a)pyrene	200 - 1,200	340	NR	NR	243	NA	NA	NA	500	3,700	NA
Dibenz(a)anthracene	120 - 760	257	NR	NR	234	NA	NA	NA	500	270,000	NA
Indeno(1,2,3-cd)pyrene	160 - 2,300	428	NR	NR	238	NA	NA	NA	5,000	650,000	NA
Pesticides (μg/kg)											
Dieldrin	3.8 - 175	175	NR	NR	103	NA	NA	NA	300	20	NA
Inorganic Analytes (mg/kg)											
Arsenic	0.42 - 2.7	2.1	NR	NR	1.8	NA	NA	NA	300	NC	0.851

[1] Values are for industrial soil, from Florida Department of Environmental Protection memoranda titled "Soil Cleanup Goals for Florida," dated September 29, 1995, and "Applicability of Soil Cleanup Goals for Florida," dated January 19, 1996.

Notes: μg/kg = micrograms per kilogram.
NR = the remedial goal option exceeds the exposure point concentration; no action is required to achieve this risk level.
NA = not applicable.
mg/kg = milligrams per kilogram.

7.0 ECOLOGICAL RISK ASSESSMENT

An ecological risk assessment (ERA) was conducted as part of the RI conducted at the North Grinder Landfill (OU 1). The purpose of the ERA was to evaluate the potential for adverse effects to ecological receptors at the North Grinder Landfill (OU 1) at NTC, Orlando and to ensure that the remedy selected for this site addresses all ecological exposure pathways and contaminants of concern.

The results of this ERA will be used in conjunction with other information gathered during the RI to evaluate the need at OU 1 for various components of the presumptive remedy for municipal landfills (USEPA, 1993b), which include the following:

- Landfill cap
- Source area groundwater control
- Leachate collection and treatment
- Landfill gas collection and treatment
- Institutional controls

The primary objective of this assessment is to determine if the landfill soil cover poses a risk to ecological receptors. Potential risks from exposure to leachate and landfill gas are also addressed.

Ecological habitats and potential ecological receptors are summarized below, followed by a discussion of chemicals detected at the site, potential ecological exposure pathways, ecological effects, and ecological risks at OU 1.

7.1 SITE CHARACTERIZATION. A detailed discussion of the ecological habitats and associated receptors potentially inhabiting the North Grinder Landfill is provided in Section 3.8. Because much of the land in the vicinity of the North Grinder landfill is developed (i.e., paved or covered by buildings), the potential wildlife habitat is limited to small areas of planted grasses and ornamental trees and shrubs. Because it is anticipated that the areas in the vicinity of the North Grinder Landfill are subject to frequent human disturbance (i.e., foot and vehicular traffic) and ecological habitat is limited, no predatory mammals or birds and no reptiles or amphibians are expected to inhabit OU 1. The only ecological receptors likely to utilize such habitat with any frequency are small mammals and species of birds commonly found in urbanized or developed areas. In addition, no rare, threatened, or endangered species are expected to occur at OU 1.

7.2 HAZARD ASSESSMENT AND CHEMICALS OF POTENTIAL CONCERN. Analytical data are available for surface soil and groundwater. A summary of these data has already been presented in the HHRA (Chapter 6.0). Table 7-1 presents a summary of the analytical data for surface soil samples collected from OU 1.

Groundwater data are also available. However, groundwater is not considered to be a significant ecological exposure medium, except as it potentially contributes to surface water and sediment contamination. Groundwater sampling results

Table 7-1
Ecological Risk Assessment of Surface Soil [1]

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Analyte	Frequency of Detection[2]	Maximum Detected Concentration	Background Concentration[3]	Analyte a CPC?[4]	Terrestrial PCL[5]	Maximum Exceeds PCL ?	Phytotoxicity Screening Value[6]	Maximum Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value[7]	Maximum Exceeds Invertebrate Screening Value?
Volatile Organic Compounds (mg/kg)										
Acetone	13/14	0.018	NA	Yes	1.4E+07	No	200	No	NA	NA
Semivolatile Organic Compounds (mg/kg)										
Acenaphthene	1/14	0.1	NA	Yes	5.1E+02	No	25	No	34	No
Anthracene	1/14	0.13	NA	Yes	5.1E+02	No	25	No	34	No
Benzo(a)anthracene	3/14	0.48	NA	Yes	5.1E+02	No	25	No	34	No
Benzo(a)pyrene	3/14	1.2	NA	Yes	5.1E+02	No	25	No	34	No
Benzo(b)fluoranthene	2/14	0.41	NA	Yes	5.1E+02	No	25	No	34	No
Benzo(g,h,i)perylene	4/14	2.5	NA	Yes	5.1E+02	No	25	No	34	No
Benzo(k)fluoranthene	3/14	4	NA	Yes	5.1E+02	No	25	No	34	No
Carbazole	1/14	0.093	NA	Yes	4.9E+02	No	NA	NA	NA	NA
Chrysene	3/14	0.5	NA	Yes	5.1E+02	No	25	No	34	No
Dibenz (a,h) anthracene	2/14	0.76	NA	Yes	5.1E+02	No	25	No	34	No
bis(2-Ethylhexyl)phthalate	4/14	0.28	NA	Yes	1.8E+03	No	1,000	No	478	No
Fluoranthene	3/14	1.1	NA	Yes	5.1E+02	No	25	No	34	No
Indeno (1,2,3-cd) pyrene	2/14	2.3	NA	Yes	5.1E+02	No	25	No	34	No
Phenanthrene	3/14	0.62	NA	Yes	5.1E+02	No	25	No	34	No
Pyrene	3/14	1.1	NA	Yes	5.1E+02	No	25	No	34	No

See notes at end of table.

Table 7-1 (Continued)
Ecological Risk Assessment of Surface Soil [1]

Remedial Investigation Report, Operable Unit 1
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Orlando, Florida

Analyte	Frequency of Detection[2]	Maximum Detected Concentration	Background Concentration[3]	Analyte a CPC?[4]	Terrestrial PCL[5]	Maximum Exceeds PCL ?	Phytotoxicity Screening Value[6]	Maximum Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value[7]	Maximum Exceeds Invertebrate Screening Value?
Pesticides and PCBs (mg/kg)										
4,4'-DDD	1/14	0.004	NA	Yes	3.8E-01	No	13	No	12	No
4,4'-DDE	8/14	0.043	NA	Yes	7.1E-01	No	13	No	12	No
4,4'-DDT	6/14	0.048	NA	Yes	1.9E+00	No	13	No	12	No
Aroclor-1260	6/14	0.15	NA	Yes	9.8E+00	No	40	No	NA	NA
alpha-BHC	7/14	0.001	NA	Yes	1.7E+01	No	1,000	No	8	No
alpha-Chlordane	3/14	0.085	NA	Yes	1.7E-01	No	13	No	NA	NA
gamma-Chlordane	11/14	0.053	NA	Yes	1.7E-01	No	13	No	NA	NA
Dieldrin	1/14	0.175	NA	Yes	1.0E+00	No	13	No	30	No
Heptachlor epoxide	10/14	0.007	NA	Yes	2.8E+00	No	13	No	6.4	No
Inorganic Analytes (mg/kg)										
Aluminum	14/14	1,031	2,088	No	NE	NE	NE	NE	NE	NE
Arsenic	10/14	2.7	1	Yes	1.5E+01	No	10	No	100	No
Barium	14/14	19.1	8.7	Yes	8.7E+03	No	500	No	NA	NA
Cadmium	4/14	1.6	0.98	Yes	5.3E+00	No	3	No	50	No
Calcium	14/14	119,000	25,295	No	NE	NE	NE	NE	NE	NE
Chromium	14/14	26.8	4.6	Yes	6.6E+03	No	1	Yes	50	No
Copper	9/14	15.2	4.1	Yes	7.8E+02	No	100	No	30	No
Iron	14/14	944	712	No	NE	NE	NE	NE	NE	NE
Lead	14/14	24.3	14.5	Yes	1.5E+02	No	50	No	1,190	No
Magnesium	12/14	922	328	No	NE	NE	NE	NE	NE	NE
Manganese	14/14	11.7	8.1	Yes	3.2E+03	No	500	No	NA	NA

See notes at end of table.

Table 7-1 (Continued)
Ecological Risk Assessment of Surface Soil [1]

Remedial Investigation Report, Operable Unit 1
North Grinder Landfill
Naval Training Center
Orlando, Florida

Analyte	Frequency of Detection[2]	Maximum Detected Concentration	Background Concentration[3]	Analyte a CPC?[4]	Terrestrial PCL [5]	Maximum Exceeds PCL ?	Phytotoxicity Screening Value[6]	Maximum Exceeds Phytotoxicity Screening Value?	Invertebrate Screening Value[7]	Maximum Exceeds Invertebrate Screening Value?
Inorganic Analytes (mg/kg) (Cont.)										
Mercury	10/14	0.74	0.07	Yes	3.9E+00	No	0.3	Yes	36	No
Potassium	1/14	105	157	No	NE	NE	NE	NE	NE	NE
Silver	3/14	6	1.8	Yes	5.7E+02	No	2	Yes	NA	NA
Thallium	1/14	0.39	2	No	NE	NE	NE	NE	NE	NE
Vanadium	11/14	5.8	3.1	Yes	3.0E+02	No	2	Yes	NA	NA
Zinc	14/14	60.1	17.2	Yes	9.0E+02	No	50	Yes	130	No
Total Petroleum Hydrocarbons (mg/kg)										
Total Petroleum Hydrocarbons	14/14	65.05	NA	Yes	NA	NA	NA	NA	NA	NA

[1] Based on analytical data for the following sample identifiers: U1S00100 through U1S01400 (including U1S00100D and U1S01100D).
[2] *Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples.*
[3] The background screening value is twice the arithmetic average of detected background concentrations for inorganic analytes.
[4] An analyte is not considered a CPC if the maximum detected concentration is less than the background value, or if the analyte is an essential nutrient, as discussed in Section 7.2.
[5] Screening values are PCLs. The value presented represents the lowest PCL for the short-tailed shrew, cotton mouse, and American robin. PCLs are presented in Appendix K, Table K-7.
[6] Phytotoxicity Screening Values are presented in Appendix K, Table K-1.
[7] Invertebrate Screening Values are presented in Appendix K, Table K-2.

Notes: CPC = chemical of potential concern.
PCL = protective contaminant levels.
mg/kg = milligrams per kilogram.
NA = not available/not applicable.
PCBs = polychlorinated biphenyls.
DDD = dichlorodiphenyldichloroethane.
DDE = dichlorodiphenyldichloroethene.
DDT = dichlorodiphenyltrichloroethane.
NE = not evaluated. The maximum detected concentration is below the background concentration, or the analyte is an essential nutrient.

discussed in Chapter 4.0 indicate that migration of contaminants (primarily radionuclides) to surface water bodies is unlikely. Therefore, the ERA focuses on evaluating potential risks associated with chemicals detected in surface soil.

Analytes detected in OU 1 surface soil include acetone, 15 semivolatiles (14 of which are PAHs), 8 pesticides, 1 PCB (Aroclor-1260), 17 inorganic analytes, and TPHs (Table 7-1). Maximum detected concentrations for inorganic analytes were compared to two times the mean background value for that analyte; a discussion of the derivation of the mean background value is provided in the HHRA (Chapter 6.0). Maximum detected concentrations of aluminum and thallium are less than two times background values; therefore, these analytes are not considered to be CPCs. In addition, calcium, iron, magnesium, and potassium were eliminated as CPCs because these analytes are essential nutrients and are only toxic to terrestrial receptors at extremely elevated concentrations (National Academy of Sciences [NAS], 1974, 1977; National Research Council [NRC], 1982; 1984). All other analytes were selected as CPCs for the ERA.

7.3 EXPOSURE ASSESSMENT. Following USEPA's directive on presumptive remedies for CERCLA municipal landfill sites (USEPA, 1993b), exposure pathways that are addressed by the presumed remedy need not be evaluated in the risk assessment. The only potential ecological exposure pathways are those associated with contaminants in surface soil, surface water, and sediment. Under the presumed remedy, no contact with landfill materials is assumed (USEPA, 1993b). As previously discussed, contaminants from the landfill have not migrated to surface water or sediment, and, therefore, from an ecological risk perspective, additional measures for source area groundwater control and leachate collection and treatment do not appear to be warranted. Groundwater, surface water, and sediment are not considered further in this ERA.

Currently, much of the landfill is paved; therefore, it is unlikely that ecological receptors would be exposed to landfill constituents. In unpaved areas, small mammals and birds may come in contact with landfill cover soil by incidental ingestion, direct contact, and inhalation. Fur, feathers, or chitinous exoskeletons likely limit the transfer of contamination across the dermis; therefore, significant exposures related to dermal contact are not expected. Exposures related to inhalation are not evaluated because this pathway is generally considered an insignificant route of exposure except in unusual circumstances, such as following a spill or release. Because of the limited habitat available at OU 1, incidental ingestion and food chain exposures for larger predatory species are unlikely to be significant.

In unpaved areas, plants and soil invertebrates (e.g., earthworms) may be exposed to chemicals in surface soil via direct contact and uptake into tissue. Soil invertebrates may also be exposed via ingestion of contaminated soil.

At the North Grinder landfill, significant contact with subsurface soil is considered unlikely for the majority of ecological receptors. It is possible that animals, including a number of small mammal species, could burrow into landfill material and be exposed. However, the likelihood of this is limited due to the developed nature of the site and the lack of a slope and/or hillside or soil mounds which are locations where animals usually tend to burrow.

Future use of the site is projected to be recreational (ABB-ES, 1996); therefore, it is possible that in the future, pavement may be removed from the site. Soil data from samples collected beneath the pavement were included in this ERA; therefore, even if pavement and/or buildings are removed and additional surface soil becomes exposed, future risks are unlikely to differ greatly from risks evaluated in this ERA.

Risks to terrestrial wildlife (small mammals and birds), plants, and soil invertebrates are evaluated in this ERA. These receptors are conservatively assumed to be exposed to the maximum detected concentration of each CPC (Table 7-1).

<u>7.4 EFFECTS ASSESSMENT</u>. Effects to small mammals and birds are measured by means of protective contaminant levels (PCLs) that are calculated using laboratory-derived toxicity data and receptor-specific exposure parameters. Toxicity data based on ecologically relevant endpoints, such as reproduction, were used to derive these PCLs. The PCLs are intended to be protective against population-level effects in ecological receptors. The derivation of PCLs is discussed in Appendix K.

Toxicity data for plants and invertebrates were selected to be protective of the survival and reproduction of these ecological receptors. A discussion of the plant and soil invertebrate toxicological values is provided in Appendix K.

<u>7.5 RISK CHARACTERIZATION</u>. To evaluate potential risks to vertebrate, invertebrate, and plant populations from exposure to landfill cover soil, exposure concentrations were compared to vertebrate PCLs and to invertebrate and plant toxicity values (Table 7-1).

The results of this comparison indicate that vertebrate and invertebrate receptors are not at risk from exposure to concentrations of analytes detected in surface soil at OU 1. In addition, terrestrial plants are not at risk from exposure to organic analytes detected in OU 1 soil. Maximum concentrations of chromium, mercury, silver, vanadium, and zinc exceed their phytotoxicity screening values. With the exception of chromium, these analytes only slightly exceed their benchmarks, suggesting that the likelihood of adverse effects to plants from exposure to these inorganic analytes is low.

The maximum chromium concentration exceeded its respective phytotoxicity benchmark by a factor of 27, indicating that plants exposed to the maximum concentration of chromium may potentially be adversely affected. Chromium was detected in all 14 surface soil samples collected at the landfill. The arithmetic mean of all concentrations calculated for chromium is approximately 7.1 mg/kg (which exceeds the phytotoxicity value by a factor of 7). The highest detected concentrations of chromium (15 mg/kg, 16 mg/kg, 27 mg/kg, and 10 mg/kg) in surface soil were detected in the unpaved, northwestern portion of the site at sample locations U1S00100, U1S00200, U1S00700, and U1S00900 (respectively). The remaining soil locations had detected concentrations of chromium ranging from 1 to 5 mg/kg.

The phytotoxicity benchmark used for chromium (1 mg/kg) was obtained from Will and Suter (1994). As discussed in Appendix K, phytotoxicity benchmarks were derived to represent the 10th percentile of the Lowest Observed Effects Concentrations (LOECs) for growth and yield endpoints. Since the number of studies included in the authors' review (n=7) was less than 10, the chromium phytotoxicity benchmark equal to the lowest LOEC was used, and a confidence level of "low" was assigned by the authors to the benchmark. The lowest LOEC was based on a decrease in fresh shoot weight for lettuce as an endpoint; therefore, exceedance of this value indicates that growth of plants in soils at concentrations in excess of 1 mg/kg could potentially be impaired. Thus, plants in the grassy area in the northwestern portion of OU 1 could potentially be adversely affected. Will and Suter (1994) recognize that the derived benchmarks are conservative means for estimating population- or community-level impacts. The conservative nature of the benchmarks, combined with the fact that the vegetation at OU 1 is limited to planted grasses and ornamental shrubs, indicates that plant populations at OU 1 are unlikely to be adversely impacted by chemicals of concern in surface soil.

The results of this risk assessment indicate that ecological receptors are unlikely to be at risk from exposure to contaminants in surface soil at OU 1.

7.6 UNCERTAINTIES. There are many uncertainties associated with the conservative approach used in the NTC, Orlando OU 1 ERA. General uncertainties associated with the risk assessment process are provided in Appendix K, Table K-8. Based on the findings of no substantial risk, and the fact that the most conservative assumptions were used in the ERA, further discussion of uncertainties is not presented.

7.7 SUMMARY AND CONCLUSIONS OF ERA. The findings of this ERA indicate that soil invertebrate and small mammalian and avian receptors are unlikely to be at risk from exposure to analytes detected in OU 1 surface soil. It is anticipated that no predatory mammals or birds, or rare and endangered species, would inhabit the site. Concentrations of chromium in surface soil, particularly in the northwestern portion of the site, exceeded the terrestrial plant screening value for this analyte. However, based on the nature of vegetation present at the site (planted grass and ornamental shrubs), risks to terrestrial plant populations are unlikely.

8.0 SUMMARY

8.1 SURFACE SOIL. The following discussion summarizes the information obtained during the RI regarding surface soils, which were collected from within landfill cover materials.

8.1.1 Nature and Extent Contaminants detected in surface soil samples collected in the landfill cover material included pesticides, a PCB compound, inorganics, and PAHs. Statistically, all these contaminants are site related, with at least one concentration occurring as outside values.

Pesticide detections at low concentrations appear to indicate a systematic use of pesticides on the parade field. PCB detections at low concentrations in surface soil samples over the parade field may indicate that oil with low PCB concentrations may have been applied to the area as a means of controlling dust.

The inorganics that statistically appear to be site-related (arsenic, calcium, chromium, copper, magnesium, and zinc), as well as other inorganics detected above background (barium, cadmium, and mercury), can probably be attributed to the systematic use of pesticides and fertilizers on landfill cover material, and the fact that the fill materials are from a different source.

PAHs in urban surface soil environments originate primarily from high temperature combustion sources such as automobile exhausts, urban fires, and boilers. However, the sample locations where PAHs were detected are adjacent to the east side of the old firefighter training pit. The PAH contamination may be derived from either windblown ash from burning flammable materials in the fire pit (the prevailing winds are westerly and southerly), or from site preparation during construction of the parade field, which may have spread the remnant of contaminated soil away from the pit.

8.1.2 Fate and Transport The leaching of contaminants from the surface soil by surface water infiltration is the primary potential migration mechanism for the transport of identified soil contaminants to groundwater. Site contaminants, because of low water solubility and high sorption to soil, do not appear to be transported outside of the landfill source area at concentrations exceeding levels of concern.

8.1.3 Risk Assessment The risk characterization results for current land-use surface soil exposure scenarios are shown in Table 6-8. For the current land-use trespasser scenario (which presumes the pavement has been removed), estimated cancer risks are within the USEPA Superfund risk range, and the noncancer HI for the child and adult trespasser are both well below 1, which is considered an allowable risk level.

For the current land-use trespasser scenario, only one compound, Dieldrin, is associated with cancer risk greater than 10^{-6}, which is the stated FDEP risk level of concern. The estimated risk of 2×10^{-6} is associated with dermal soil contact (1.2×10^{-6}) and incidental ingestion (6×10^{-7}). The risk estimate is based on the maximum reported concentration of Dieldrin (175 μg/kg). The mean of detected Dieldrin concentrations is 56 μg/kg, which is below the residential and industrial cleanup goals for Florida, which are 70 μg/kg and 300 μg/kg, respectively. It should also be noted that the pavement is still in place, so that under current conditions, there really is not any exposure to the surface soils in the immediate area of the former landfill. Therefore, risks associated with surface soil exposure under current land use are within acceptable limits.

The risk characterization results for future land use potential surface soil exposure scenarios are shown in Table 6-8. For potential future land uses, estimated cancer and noncancer risks for the recreational user (child and adult), onsite worker, and an excavation worker are within acceptable ranges specified for the USEPA Superfund program. Estimated cancer risks for the recreational user, site worker, and the excavation worker are $2x10^{-6}$, $6x10^{-6}$, and $1x10^{-7}$, respectively. Calculated HI values for the same receptors are 0.02, 0.02, and 0.009, all well below 1, which is considered an allowable level.

For the recreational user, only Dieldrin has an estimated cancer risk greater than 10^{-6}, which is the FDEP's stated risk level of concern. The estimated risk of $2x10^{-6}$ is associated with dermal soil contact ($1.2x10^{-6}$) and incidental ingestion ($6x10^{-7}$). The risk estimate is based on the maximum reported concentration of Dieldrin (175 μg/kg). The mean of detected Dieldrin concentrations is 56 μg/kg, which is below the industrial cleanup goal for Florida, which is 300 μg/kg. With a deed restriction prohibiting residential use, the Dieldrin concentrations would be consistent with the Florida cleanup goals.

For the potential future site worker, cancer risks associated with benzo(a)pyrene ($1.4x10^{-6}$), dibenz(a,h)anthracene ($1.1x10^{-6}$), Dieldrin ($1.7x10^{-6}$), and arsenic ($1.2x10^{-6}$) slightly exceed 10^{-6}, which is the stated FDEP risk level of concern. However, the EPCs for each of these four analytes is less than the corresponding industrial cleanup goals for Florida: benzo(a)pyrene EPC of 340 μg/kg versus a cleanup goal of 500 μg/kg; dibenz(a,h)anthracene EPC of 257 μg/kg versus a cleanup goal of 500 μg/kg; Dieldrin EPC of 175 μg/kg versus a cleanup goal of 300 μg/kg; and arsenic EPC of 2.1 mg/kg versus a cleanup goal of 3.1 mg/kg. With deed restrictions that prevent residential use of the property, risks meet the USEPA risk limits, and site concentrations are consistent with industrial soil cleanup goals for Florida.

8.2 GROUNDWATER. The following discussion summarizes the information obtained during the RI regarding groundwater, which was collected from 29 monitoring wells (nine clusters of three each and one cluster of two) from the vicinity of the North Grinder Landfill.

8.2.1 Nature and Extent Contaminants detected in the groundwater that exceed background and/or regulatory standards consisted of gross radioactivity and some inorganics. Relative to analytical results of samples from both background and downgradient monitoring wells, gross alpha and gross beta are elevated in the groundwater in the immediate vicinity of the landfill at depths that are within the Hawthorn Group phosphatic sands above the upper clay layer. Elevated gross alpha activity was not detected in samples from any shallow wells, nor from any wells downgradient and outside the immediate vicinity of the landfill. The same is true for gross beta except for one shallow well, OLD-U1-07A.

Monitoring wells screened in groundwater with elevated gross alpha and beta activity were resampled for specific radionuclides to identify radioactive constituents. Specific radionuclides selected for analysis were based on most probable sources (radium paint and natural sources), and included major contributors in the uranium-238 series, potassium-40, and cesium-137.

There is significant evidence that supports the hypothesis that naturally occurring radionuclides associated with phosphates of the Hawthorn Group are being mobilized by anaerobic microbial activity at that depth. Of the radionuclides scanned, the significant contributions are from members of the naturally occurring uranium-238 series and potassium-40, which suggests that the remaining contributors are likely naturally occurring radionuclides as well.

8.2.2 Fate and Transport Elevated (above background or MCL) gross alpha and/or beta were detected in groundwater samples from intermediate to deep monitoring wells located adjacent to the perimeter of the landfill. This has lead ABB-ES to conclude that the radiological contamination is due to mobilization of naturally occurring radionuclides rather than to buried radioactive material in the landfill. The natural uranium-238 series radioisotopes, which are known to be associated with the phosphates of the Hawthorn deposits, appear to be mobilized in the vicinity of the landfill and do not occur farther downgradient.

This mobilization is best explained by a change in groundwater chemistry due to indigenous bacteria enhancement by the landfill leachate. The organics in the leachate are transported by a steep downward hydraulic head differential in the southwest corner of the landfill. The leachate enhances the activity and density of bacteria in the basal zone of the surficial aquifer, and the redox potential decreases. As long as the landfill produces leachate, the reducing conditions created by the microorganisms will continue to reduce minerals of the Hawthorn deposits, and the radionuclides associated with these compounds will continue to be mobilized into the aquifer. Eventually, as the landfill ages and as fresh groundwater moves through, the groundwater chemistry below the landfill will return to background concentrations.

Farther downgradient from the landfill, the leachate is diluted and the bacteria density is normal. As the low Eh groundwater mixes with oxygenated groundwater, forming uranyl complexes, which are readily sorbed on colloidal particles such as organics, ferric hydroxides, and clays, radionuclides are largely precipitated out of solutions, reducing radionuclide activity below levels of concern. It appears that natural processes controlling groundwater Eh are preventing downgradient migration of the mobilized radionuclides. Therefore, downgradient surface water bodies, such as Lake Spier and Lake Berry, are apparently not threatened by elevated radionuclides at the landfill.

8.2.3 Risk Assessment A risk assessment was not performed for groundwater because no receptors were identified for either current or future use of the landfill, since no potable drinking water wells are in place or will be installed in the future. However, maximum detected groundwater concentrations were compared to FDEP Drinking Water Standards. This comparison indicated that groundwater is unsuitable as a source of drinking water and, therefore, institutional controls to prevent such use are required.

8.3 CONCLUSIONS. ABB-ES concludes the information below from the data gathered during this RI:

- Elevated levels of PAHs in surface soil analytical results from three adjacent samples in the east-central portion of the landfill pose cancer risks that are well within the levels of risk acceptable to the USEPA and are consistent with industrial SCGs for Florida.

- Elevated gross alpha and beta radiological activity is likely due to natural sources that are being mobilized by altered groundwater chemistry under the landfill and at its fringes. With sufficient institutional controls in place (deed restrictions, cover maintenance), future users of the property will not be exposed to groundwater with elevated radiological parameters; therefore, no risk will be incurred.

- A landfill cap will not be required due to the relatively low levels of surface soil contamination detected in landfill cover materials.

- A groundwater monitoring program for downgradient wells to observe changes in groundwater contaminants as a function of time is recommended.

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APPENDIX A

GEOPHYSICAL SURVEYS

TECHNICAL MEMORANDUM

GEOPHYSICAL SURVEYS
OPERABLE UNIT 1, NORTH GRINDER LANDFILL

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

Unit Identification Code (UIC): N65928

Contract No.: N62467-89-D-0317

Prepared by:

ABB Environmental Services, Inc.
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Prepared for:

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Naval Facilities Engineering Command
2155 Eagle Drive
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Barbara Nwokike, Code 1873, Engineer-in-Charge

December 1996

LIST OF FIGURES

ATTACHMENTS

TECHNICAL MEMORANDUM

PROJECT: OU 1, North Grinder Landfill
Naval Training Center, Orlando

SUBJECT: Geophysical Surveys

PREPARED BY: Richard Allen, Principal Scientist

DATE: February 21, 1996

1.0 INTRODUCTION

A geophysical survey was conducted at Operable Unit 1, North Grinder Landfill, located in the northwest portion of the Main Base of the Naval Training Center, Orlando. The objectives for the survey were to do the following:

- determine the "footprint" of the North Grinder Landfill;
- determine whether or not the South Grinder parade area shows any geophysical anomalies that indicate it to be a former landfill;
- locate "hot spots" in the North Grinder Landfill that might indicate concentrations of buried conductive and/or ferrous wastes, and, therefore areas within the landfill that might warrant source removal to support the selected remedial alternative; and
- characterize, to the extent possible with remote sensing techniques, the landfill cover thickness and continuity.

Geophysical techniques employed during these surveys included magnetometry (MAG), terrain conductivity (TC), time domain metal detector (TDMD), and ground penetrating radar (GPR). Figure 1 shows the area of the investigation and outlines the approximate boundaries of each of the geophysical techniques used in the survey.

Figure 2 shows the North Grinder Parade area (located east of the reviewing stand, Building 207, and the presumed location of landfilled materials derived from historical information, including aerial photographs. Historical information was used in the planning stages of the investigation.

The field program was conducted between March 7 and April 6, 1995.

2.0 PERSONNEL

ABB Environmental Services, Inc. (ABB-ES) personnel involved in the field program include William Olson, Geologist, Marc Hawes, Associate Geologist; Robert Burns, Associate Engineer; and John Nash, Geologist. Greg Mudd was the Field Operations Lead during the investigation. Overall direction for the field program was provided by Richard Allen, Principal Scientist and Project Technical Lead.

3.0 FIELD PROGRAM

3.1 SURVEY GRID AND GLOBAL POSITIONING SURVEY. Prior to the start of the field program, ABB-ES established an arbitrary grid coordinate system oriented along magnetic north (shown on all following figures), and parallel to the north-south system of sidewalks and roads in the area. The grid consisted of a 100- by 100-foot grid established over the survey area (Figure 1) with a cloth measuring tape and transit.

Subsequent to the completion of field work, ABB-ES completed a global positioning survey in which 2 buildings (Building 206 and Building 208, the U.S.S. Bluejacket), several roadways, 21 monitoring wells, 3 piezometers, and 12 grid nodes were mapped with approximately 1 meter accuracy. A Trimble ProXL global positioning receiver coupled with a DCI (Differential Corrections, Inc.) FM receiver for the differential global positioning system (DGPS) signal was employed.

The term GPS (Global Positioning System) refers to the constellation of 25-odd satellites deployed by the U.S. Department of Defense. These satellites provide users on the ground with a means of accurately locating their position anywhere on the earth's surface through triangulation. With GPS, we can accurately locate site features, roads and other landmarks to an accuracy of less than 1 meter when the differential correction is applied to uncorrected GPS field data. GPS data is recorded in a data logger and can be imported to a CAD-based site map for near real-time location control. Attachment A (page A-A-1) contains additional information on this emerging technology.

3.2 TIME DOMAIN METAL DETECTOR SURVEY. A TDMD survey was conducted over the area shown on Figure 1 between March 20 and March 22, 1995. The survey consisted of 22 parallel north-south traverses separated by either 50 or 100 feet. Data are acquired along each traverse at the rate of 1.60 readings per foot (1 reading every 19 centimeters). A total of 28,300 lineal feet of coverage, with more than 42,400 readings were acquired during the investigation. The instrumentation consisted of a Geonics EM-61 time domain metal detector with Polycorder high capacity data logger.

The EM-61 TDMD was designed to map buried conductive objects, such as metal tanks, drums, and utilities. The instrument incorporates an antenna system consisting of a transmitter and receiver. The transmitter produces a series of electromagnetic (EM) wavelets which pulse into the earth 75 times per second. After each pulse, a secondary EM field is produced briefly from moderately conductive shallow soils, and for a longer period of time from buried metallic objects. Between primary EM pulses, a time delay is imposed upon the data logger to permit the secondary response from the soils to dissipate prior to the somewhat later and longer response from any buried metal that is present. The receiver senses the secondary responses from metallic objects and they are recorded by the data logger.

3.3 MAGNETOMETER AND TERRAIN CONDUCTIVITY SURVEY. The magnetometer and terrain conductivity surveys were conducted concurrently over the area shown on Figure

1 between March 22 and March 27, 1995. The instrumentation consisted of an EDA OmniPlus proton precession magnetometer with vertical gradient capability and a Geonics EM-31 terrain conductivity meter with Polycorder data logger. The survey was conducted on either a 20- by 20-foot measurement grid or a 20- by 40-foot measurement grid.

The magnetic method is a versatile geophysical technique used for evaluating shallow geologic structures and for locating buried manmade objects and buried debris by mapping local distortions in the earth's magnetic field produced by buried magnetic objects (steel and other magnetic materials). Vertical gradient measurements of the earth's magnetic field are often taken during environmental magnetic surveys, as they are more sensitive to the presence of near-surface metal objects than total field values alone. Attachment B (page A-B-1) presents additional information on the principles and applications of this geophysical method.

Terrain conductivity surveys, also referred to as EMI (electro-magnetic induction) surveys, have traditionally been used in mineral exploration for tracing conductive ore bodies (i.e., massive sulfides). More recently, conductivity surveys have been used in environmental studies for mapping buried debris and former structures, and for tracing conductive contaminant plumes in groundwater. TC instruments record two parameters, the quadrature phase and the in-phase components of an induced magnetic field. The quadrature-phase component is a measure of the ground conductivity value expressed in millimhos per meter. The in-phase component is significantly more sensitive to metallic objects and is useful for looking for buried tanks and drums and other manmade objects. Attachment C (page A-C-1) presents additional information on this technique.

A total of 2,841 magnetometer and 2,915 terrain conductivity measurements were acquired during the investigation.

<u>3.4 GROUND PENETRATING RADAR SURVEY</u>. A ground penetrating radar (GPR) survey was conducted on April 4 through 6, 1995. The purpose for this work was to confirm the landfill footprint determined with MAG, TC and TDMD, and to evaluate the landfill cover thickness and continuity. The instrumentation consisted of a GSSI SIR 3 radar system with 300 MHz and 500 MHz antennas.

The GPR technique uses high frequency radio waves to determine the presence of subsurface objects and structures. The radio wave energy is reflected from surfaces where there is a contrast in the electrical properties of subsurface materials, such as naturally occurring geologic horizons or manmade objects (e.g., buried utilities, tanks, drums). Typical applications for GPR include mapping buried utilities and delineating the boundaries of buried hazardous waste materials and abandoned landfills. Attachment D (page A-D-1) presents additional information on this geophysical method.

4.0 RESULTS

4.1 SURVEY GRID AND GLOBAL POSITIONING SURVEY. The arbitrary survey grid established by ABB-ES with a cloth tape and level is shown on Figure 1. Shown on Figure 3 and Table 1 are the results of the GPS survey conducted at OU 1 in which the corners of 2 buildings (Building 206 and Building 208, the U.S.S. Bluejacket), several roadways, 21 monitoring wells, 3 piezometers, and 12 grid nodes were mapped with approximately 1-meter accuracy. A Trimble ProXL global positioning receiver coupled with a DCI (Differential Corrections, Inc.) FM receiver for the differential global positioning system (DGPS) signal was employed. The buildings, grid nodes, monitoring wells and piezometers were mapped with a minimum of 30 fixes and are estimated to be accurate to within approximately 1 meter. The locations for the roads are based on single fixes taken from a moving vehicle and are estimated to be accurate within approximately 2 to 3 meters.

4.2 TIME DOMAIN METAL DETECTOR SURVEY. The results of the TDMD survey are presented as Figures 4 and 5. Also shown on these figures are the individual TDMD traverses completed during this study. There is an upper and a lower coil (Channel [1] and Channel [2], respectively, on the data output) on the EM-61 TDMD. Figure 4 is a contour map in millivolts of the lower coil, which is more sensitive to shallow buried objects. Figure 5 is a contour map of the vertical gradient between the upper and lower coils (dimensionless). The gradient values minimize the effects of near surface metallic materials. Thus, Figure 4 maps shallow metallic objects, whereas Figure 5 maps relatively deeper objects.

4.3 MAGNETOMETER AND TERRAIN CONDUCTIVITY SURVEY. Figure 6 presents the locations for all MAG and TC measurements. The survey grid over the suspected area of landfilling was 20 by 20 feet. In areas less likely to be subject to landfilling, the grid was relaxed to 20 by 40 feet (north of coordinate 3700N and south of 2800N).

The results of the magnetometer and terrain conductivity surveys are presented as Figures 7, 8 and 9. Figure 7 presents the magnetic vertical gradient contours with a contour interval of 10 gammas per meter.

Vertical gradient measurements are very useful in mapping the lateral extent of landfilled materials, since nearly all landfills contain sufficient ferrous materials to be mapped with this technique. As anticipated during the site walkover prior to the start of the geophysical survey, the survey area contains some cultural features that have produced significant distortion in the magnetic data. Such features include buried utilities, light poles, vehicles, fencing, buildings, and overhead power lines. Accordingly, only those portions of the study area sufficiently far removed from these surface and buried sources of magnetic interference can be used to assess the presence or absence of landfilled materials and potential contaminant sources. Magnetic disturbances from cultural features rendered some of the data collected during this investigation unusable for evaluation.

Table 1
GPS Survey At North Grinder Landfill

Geophysical Surveys Operable Unit 1, North Grinder Landfill
Naval Training Center
Orlando, Florida

Northing	Easting	Comments			
1541105	547142	GRIDPT	OU 1	X=2000	Y=2000
1541105	547341	GRIDPT	OU 1	X=2200	Y=2000
1541105	547542	GRIDPT	OU 1	X=2400	Y=2000
1541506	547642	GRIDPT	OU 1	X=2500	Y=2400
1541915	548634	GRIDPT	OU 1	X=3200	Y=2800
1541915	548635	GRIDPT	OU 1	X=3500	Y=2800
1542114	548635	GRIDPT	OU 1	X=3500	Y=3000
1542313	548635	GRIDPT	OU 1	X=3500	Y=3200
1542416	548632	GRIDPT	OU 1	X=3500	Y=3300
1543113	548524	GRIDPT	OU 1	X=3400	Y=4000
1543208	548115	GRIDPT	OU 1	X=3000	Y=4100
1543101	547324	GRIDPT	OU 1	X=2200	Y=4000
1542839	547465	Building	OU 1	NWBLDG0208	
1542838	547721	Building	OU 1	0EBLDG0208	
1542817	547461	Building	OU 1	SWBLDG0208	
1542788	547306	Monitoring Well	OU 1	U10302	
1542785	547303	Monitoring Well	OU 1	U10301	
1542791	547311	Monitoring Well	OU 1	OU0303	
1542380	547133	Monitoring Well	OU 1	OU0201	
1542383	547133	Monitoring Well	OU 1	U10202	
1542387	547135	Monitoring Well	OU 1	U10203	
1541976	547140	Monitoring Well	OU 1	U10101	
1541985	547139	Monitoring Well	OU 1	U10102	
1541990	547144	Monitoring Well	OU 1	U10103	
1541782	547293	Building	OU 1	NWBLDG0206	
1541781	547295	Building	OU 1	NWBLDG0206	
1541805	547586	Building	OU 1	NEBLDG0206	
1541592	547592	Building	OU 1	SEBLDG0206	
1541586	547299	Building	OU 1	SWBLDG0206	
1541531	547257	Monitoring Well	OU 1	GMMW1	
1542846	547369	Monitoring Well	OU 1	GMMW2	
1542821	548101	Monitoring Well	OU 1	GMMW3	
1542273	548383	Monitoring Well	OU 1	U1PZ3	
1542354	547691	Monitoring Well	OU 1	U1PZ2	
1542098	547137	Monitoring Well	OU 1	U1PZ1	
1541783	547831	Monitoring Well	OU 1	U10901	
1541790	547834	Monitoring Well	OU 1	U10902	

Table continued on next page.

Table 1 (Continued)
GPS Survey At North Grinder Landfill

Geophysical Surveys Operable Unit 1, North Grinder Landfill
Naval Training Center
Orlando, Florida

Northing	Easting	Comments		
1541800	547830	Monitoring Well	OU 1	U10903
1541912	548329	Monitoring Well	OU 1	U10801
1541916	548332	Monitoring Well	OU 1	U10802
1541922	548320	Monitoring Well	OU 1	U10803
1542796	548013	Monitoring Well	OU 1	U10501
1542793	548013	Monitoring Well	OU 1	U10502
1542804	548020	Monitoring Well	OU 1	U10503

Notes: GPS = Global Positioning System.
OU = Operable Unit.

Figures 8 and 9 were produced from the terrain conductivity data. Figure 8 presents the quadrature contours and represent conductivity values in units of millimhos per meter. A contour interval of 10 millimhos per meter is used on Figure 8. Figure 9 presents the in-phase component of the conductivity measurement, which is significantly more sensitive to metallic objects and thus is useful in searching for buried metal objects. Data from the in-phase component may be thought of as being equivalent to a metal detector survey. A contour interval of 2 (dimensionless units) was used on Figure 9.

Conductivity contours are also useful for mapping the lateral extent of landfilled materials, although the instrumentation measures a different physical parameter (i.e., conductivity) and permits an evaluation independent of magnetic data.

4.4 GROUND PENETRATING RADAR SURVEY. Ground penetrating radar traverses were completed along 30 traverses indicated on Figure 10. Several typical sections of GPR recordings are presented in Attachment D. The data were generally of good to excellent quality. Some of the most salient features noted in the data include the fill surface underlying the parking lot in which historical accounts indicate that subsidence had taken place requiring that fill be brought in to repair the surface.

5.0 CONCLUSIONS

As anticipated, interference from cultural objects limited the effectiveness of the MAG and TC data in assessing subsurface conditions in some portions of the site, in particular, the area on the eastern boundary of the Landfill in the vicinity of Buildings 212, 214, 232, and 234. Likewise, the TDMD data were of limited usefulness in this area. Two GPR traverses conducted in this area were useful in establishing the eastern limit of landfilling. An interpretation of the combined results of the TDMD, MAG, TC, and GPR has resulted in Figure 11, which shows the footprint of the landfill based on all of the geophysical data. The southern and western limits of landfilling were best demonstrated by the vertical gradient contours, Figure 7, in which the southern limit is interpreted to be approximately 2750N and the western limit is conservatively established at 2120E. The northern limit is consistent in the magnetic contours (Figure 7), TDMD contours (Figures 4 and 5), and TC (quadrature) contours (Figure 8). GPR data were useful in establishing the eastern extent of the landfilling. Cultural features (Buildings 212 and 214, sidewalks, and buried utilities) limited MAG, TC, and TDMD effectiveness in this area.

During the magnetometer survey, a reconnaissance MAG survey was conducted in the South Grinder Parade Area. During this work, several hundred magnetic readings along 8 or 9 north-south traverses were taken throughout the area. The presence of landfilled materials results in lateral changes in vertical gradient values in the order of 20 gammas/meter or greater over distances of several feet. No anomalous values suggestive of prior landfilling activities were noted.

There are several areas within the North Grinder Landfill that could be considered potential hot spots. However, the apparent lack of any significant organic and inorganic contamination downgradient from the landfill determined from several monitoring well clusters suggests that these potential areas are likely only zones where ferrous materials, for whatever reason, may have been concentrated during disposal.

GPR was not successful in determining cover thickness, probably because of the manner in which materials were disposed of. It is likely that landfill materials were burned and then covered, producing a substrate composed primarily of fine sand, along with some ash and inflammable debris. Landfills which are not burned typically have absorbent materials such as fabric and paper products that retain moisture and produce a distinct horizon between cover materials (sand) and landfilled wastes.

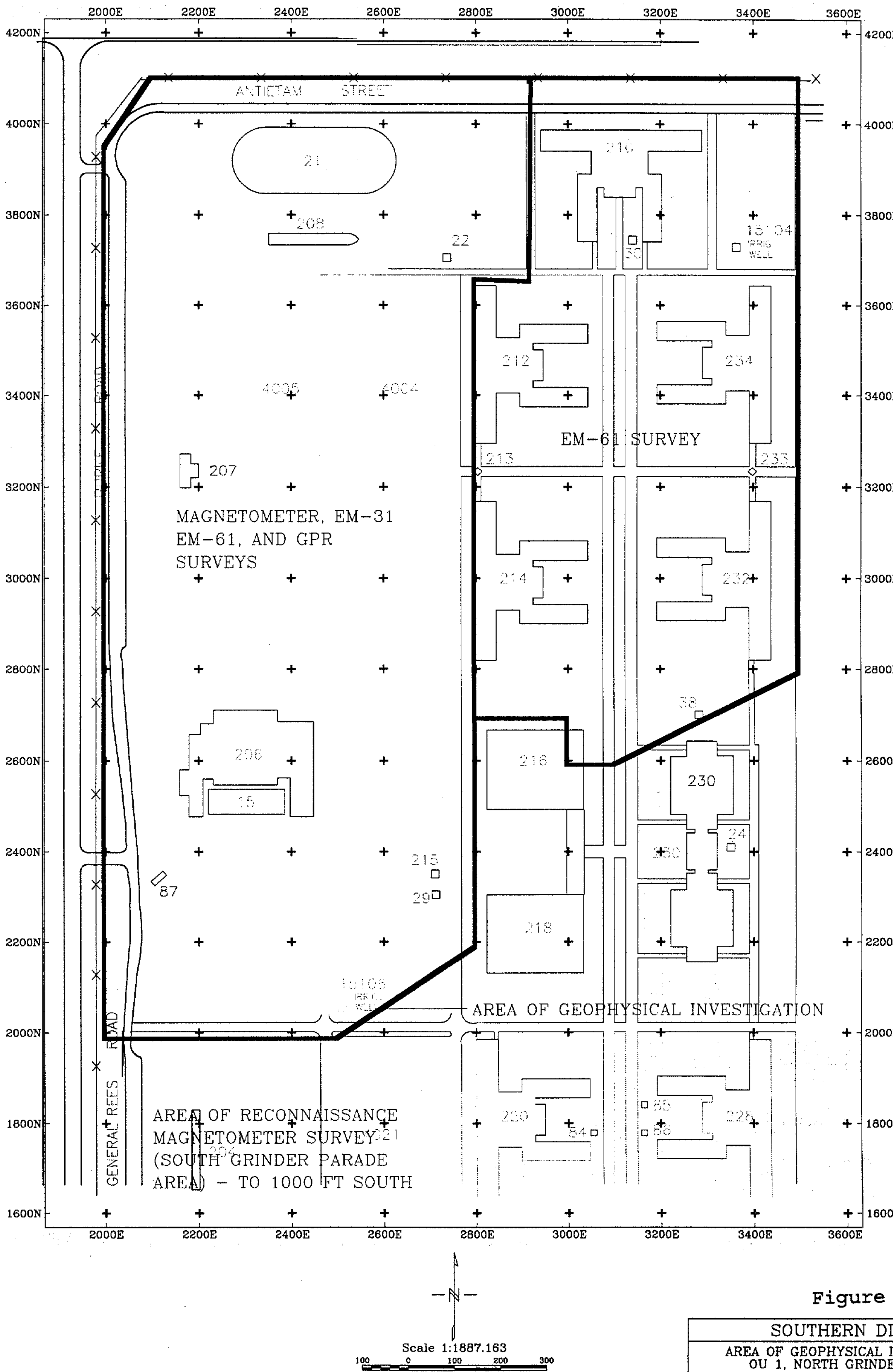

Figure 1

SOUTHERN DIVISION
AREA OF GEOPHYSICAL INVESTIGATIONS OU 1, NORTH GRINDER LANDFILL
ABB ENVIRONMENTAL SERVICES, INC.

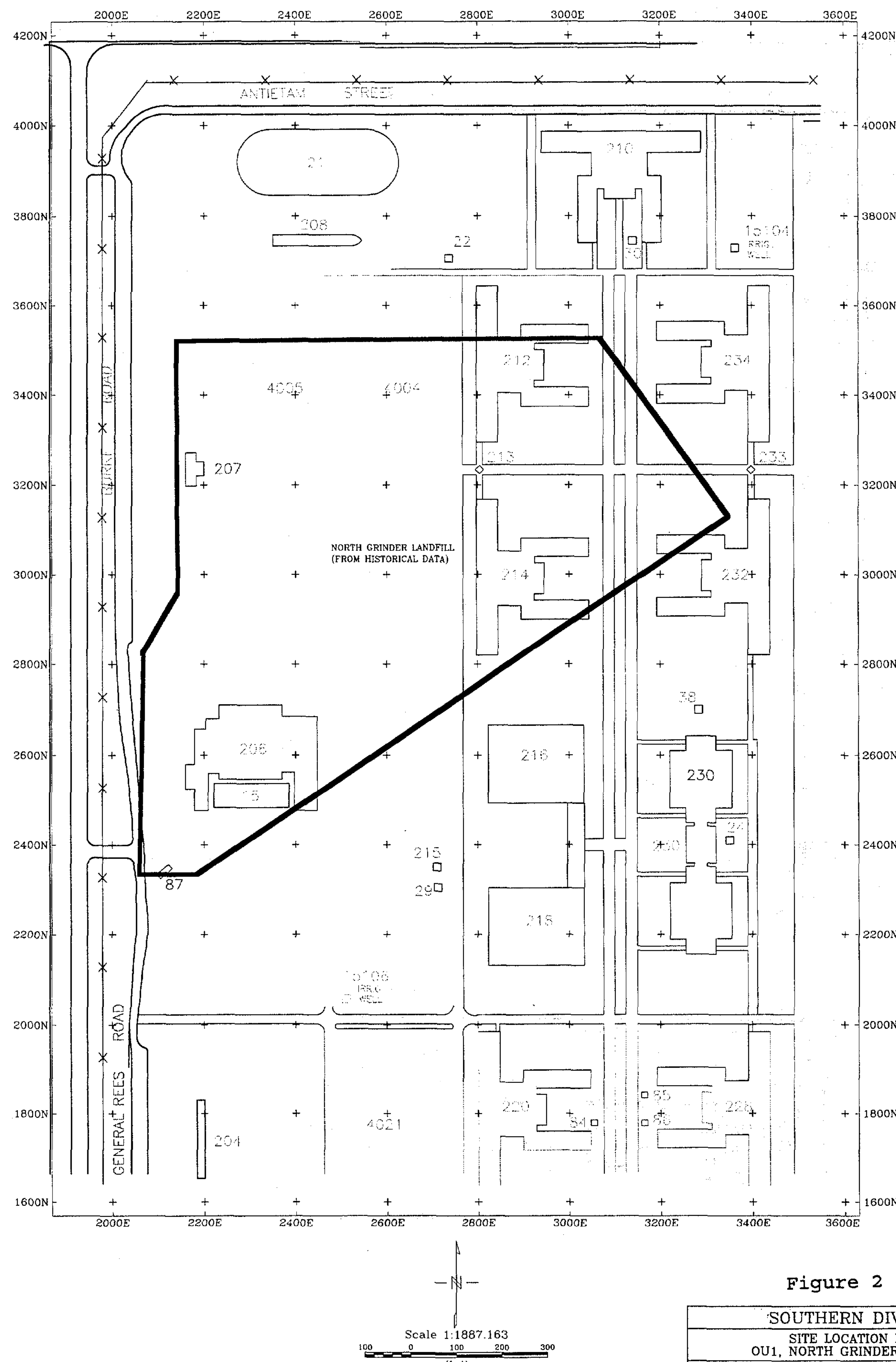

Figure 2

SOUTHERN DIVISION
SITE LOCATION PLAN OU1, NORTH GRINDER LANDFILL
ABB ENVIRONMENTAL SERVICES, INC.

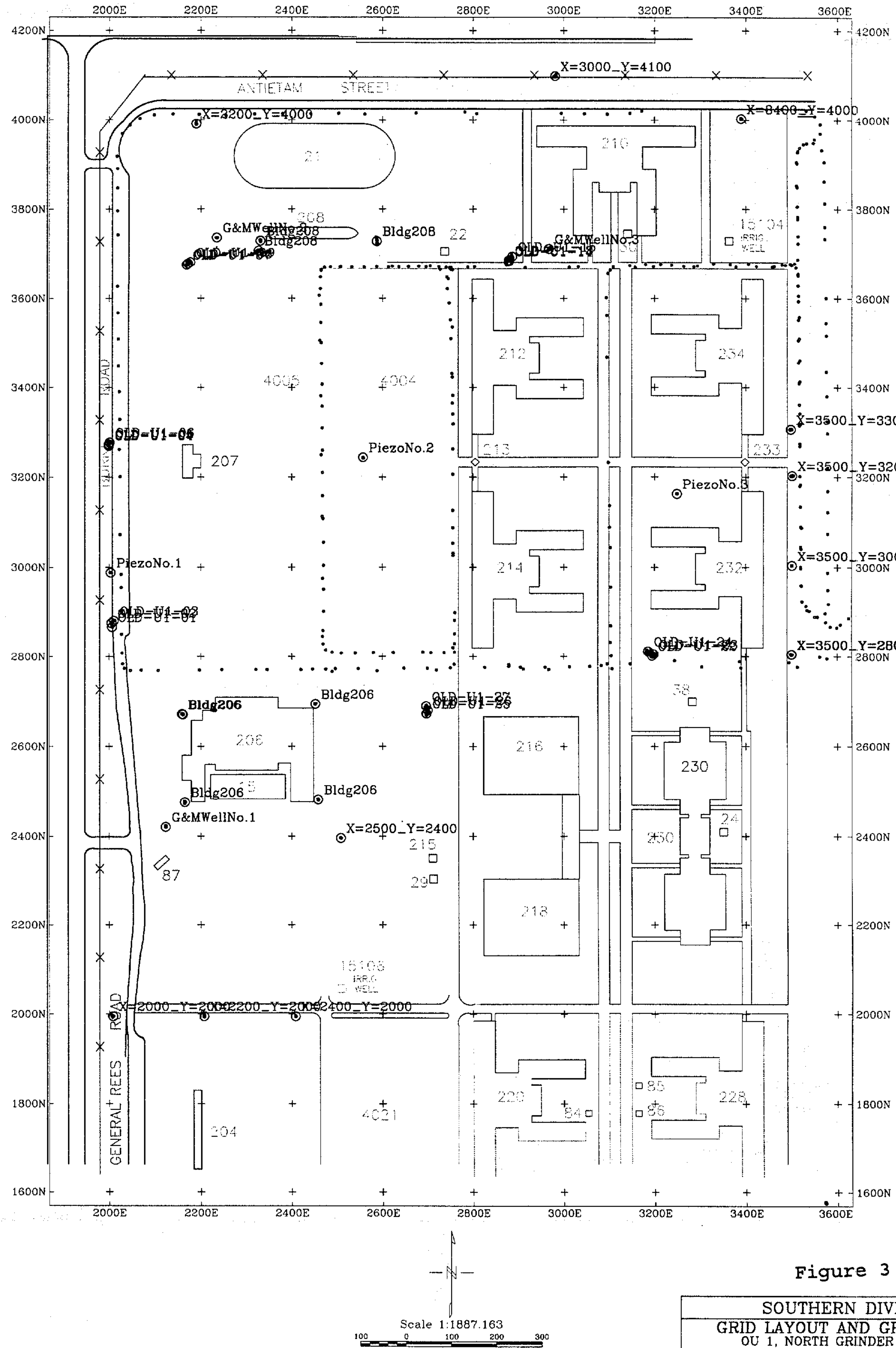

Figure 3

SOUTHERN DIVISION

GRID LAYOUT AND GPS SURVEY

OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

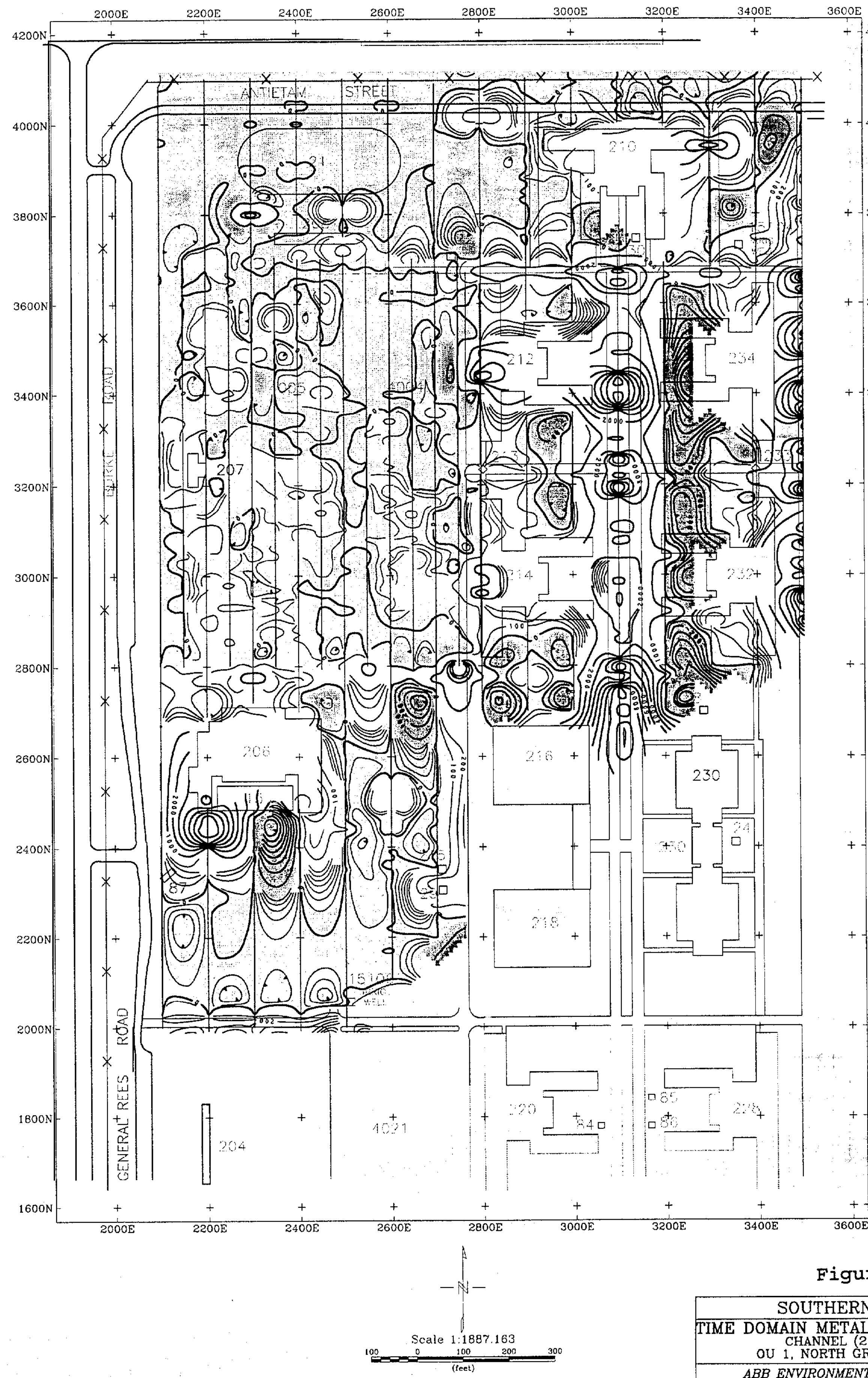

Figure 4

SOUTHERN DIVISION

TIME DOMAIN METAL DETECTOR SURVEY
CHANNEL (2) CONTOURS
OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

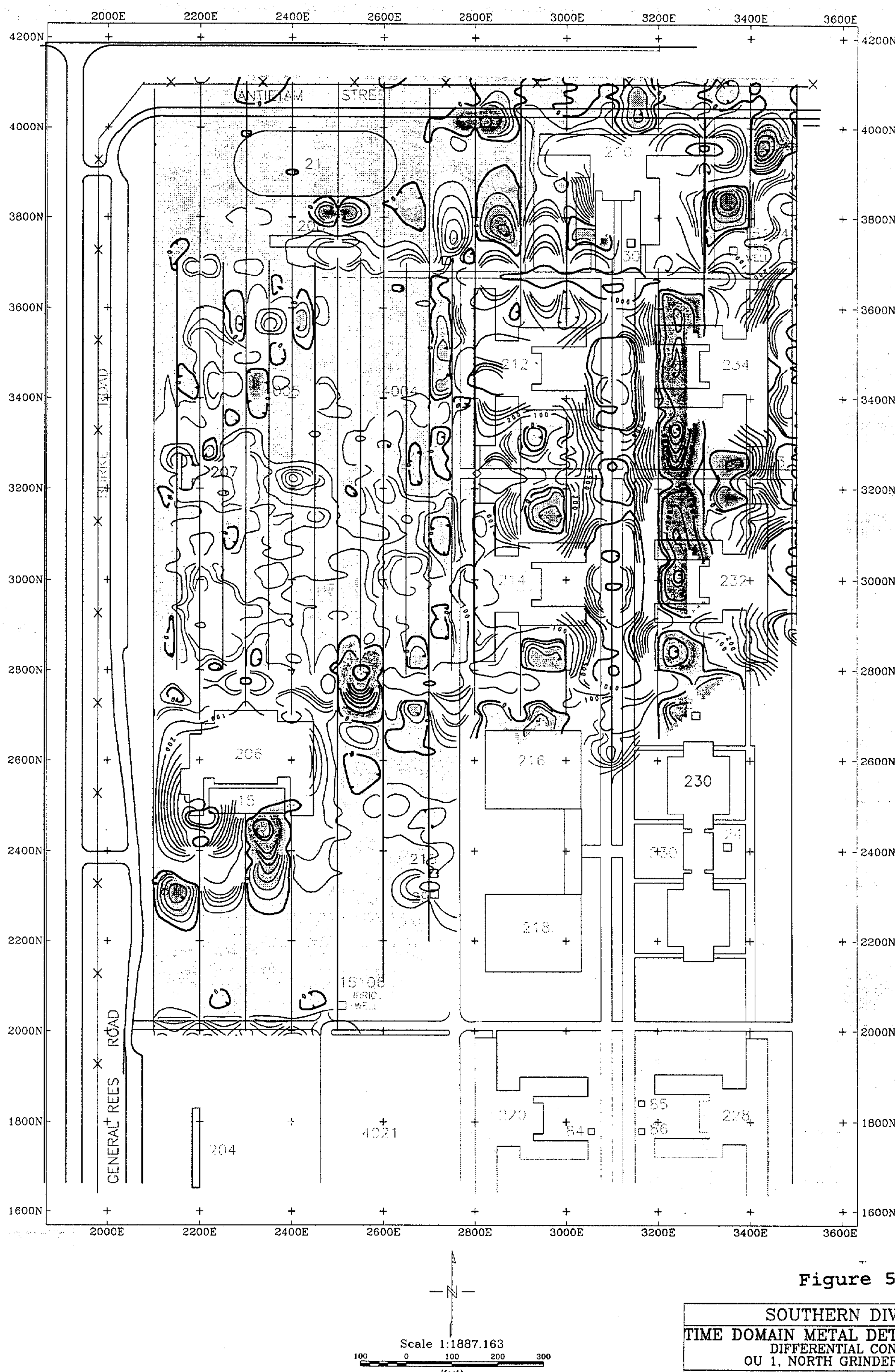

Figure 5

SOUTHERN DIVISION

TIME DOMAIN METAL DETECTOR SURVEY
DIFFERENTIAL CONTOURS
OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

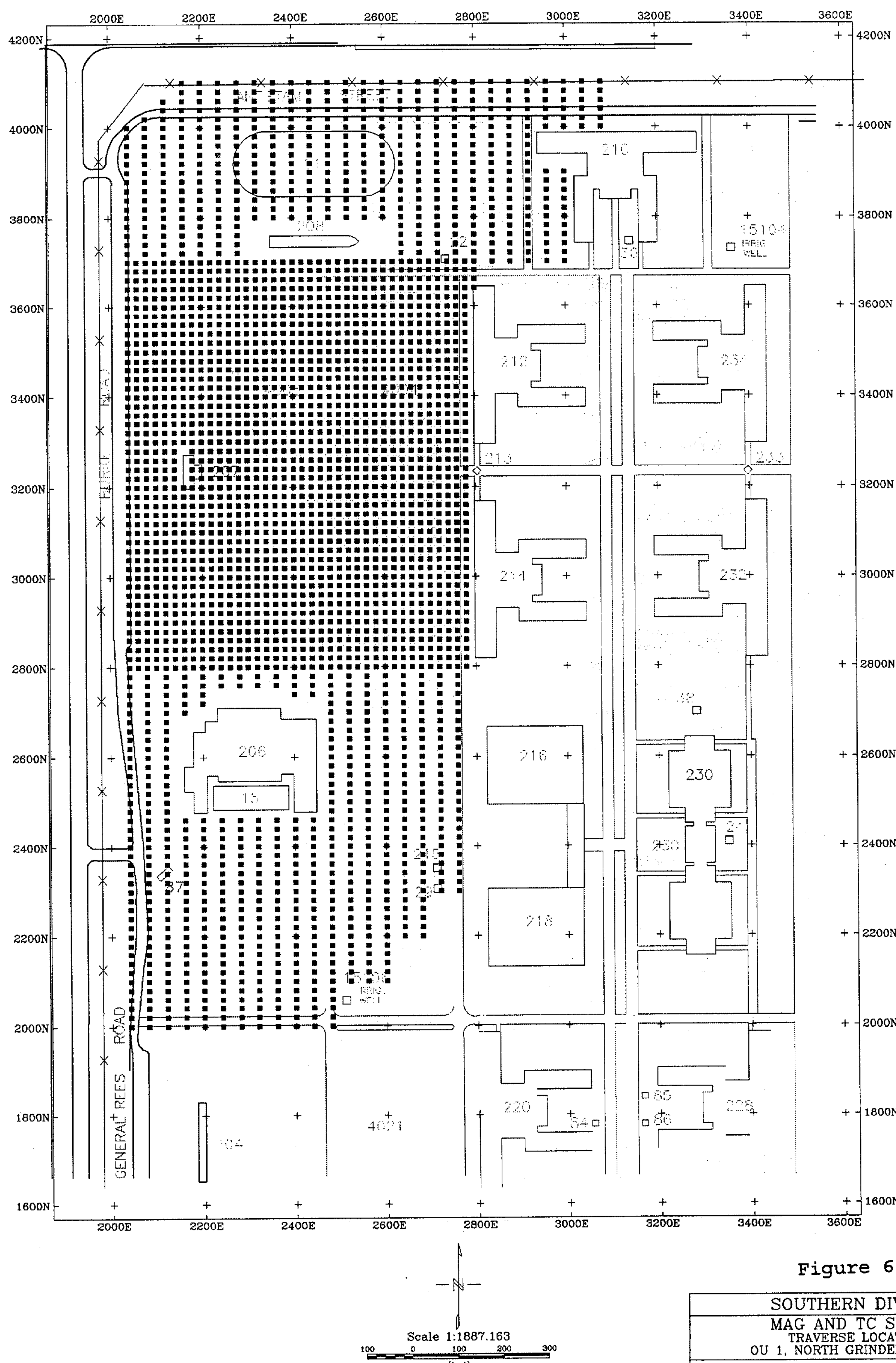

Figure 6

SOUTHERN DIVISION

MAG AND TC SURVEY
TRAVERSE LOCATIONS
OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

7

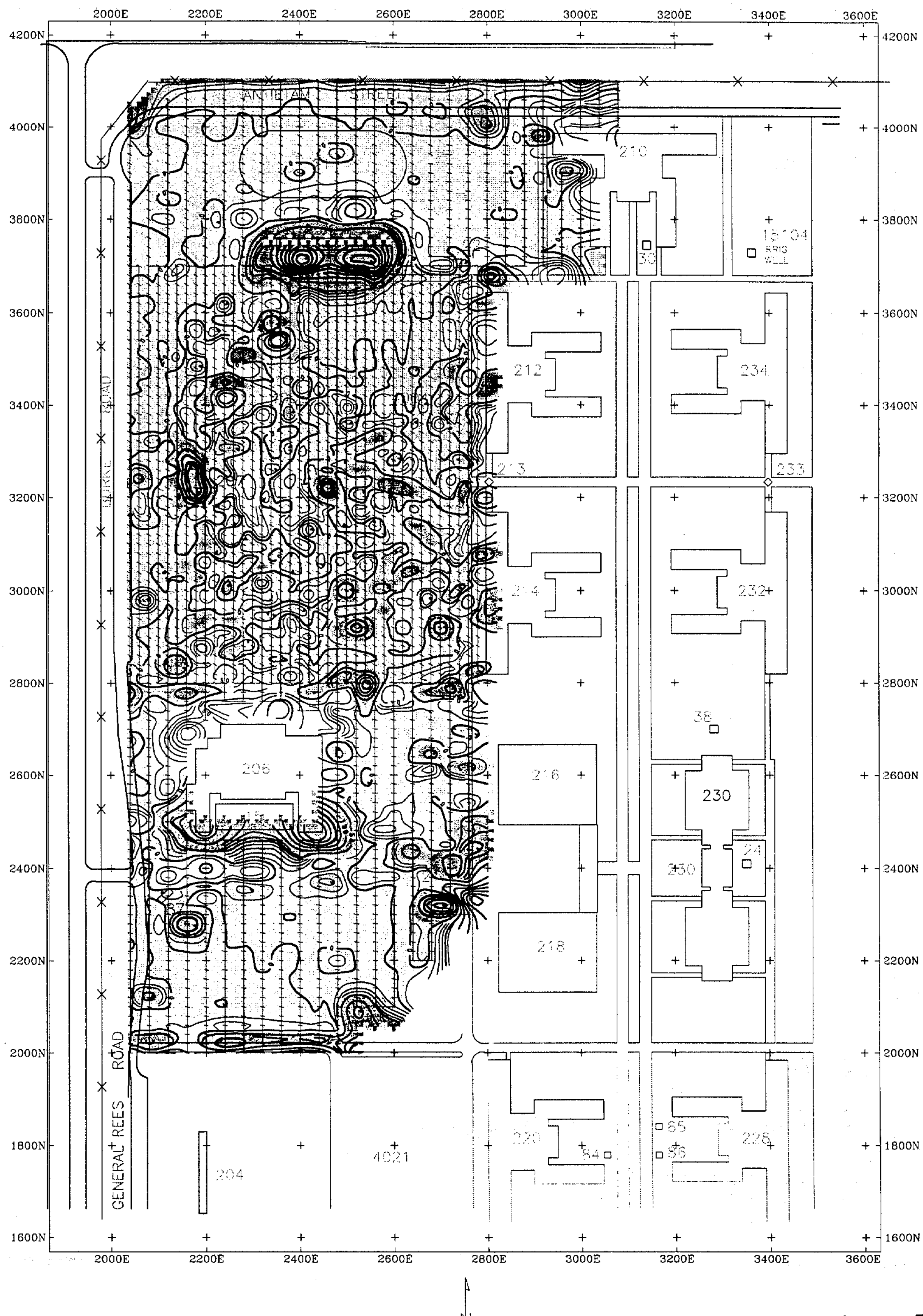

Figure 7

SOUTHERN DIVISION

VERTICAL GRADIENT CONTOURS

OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

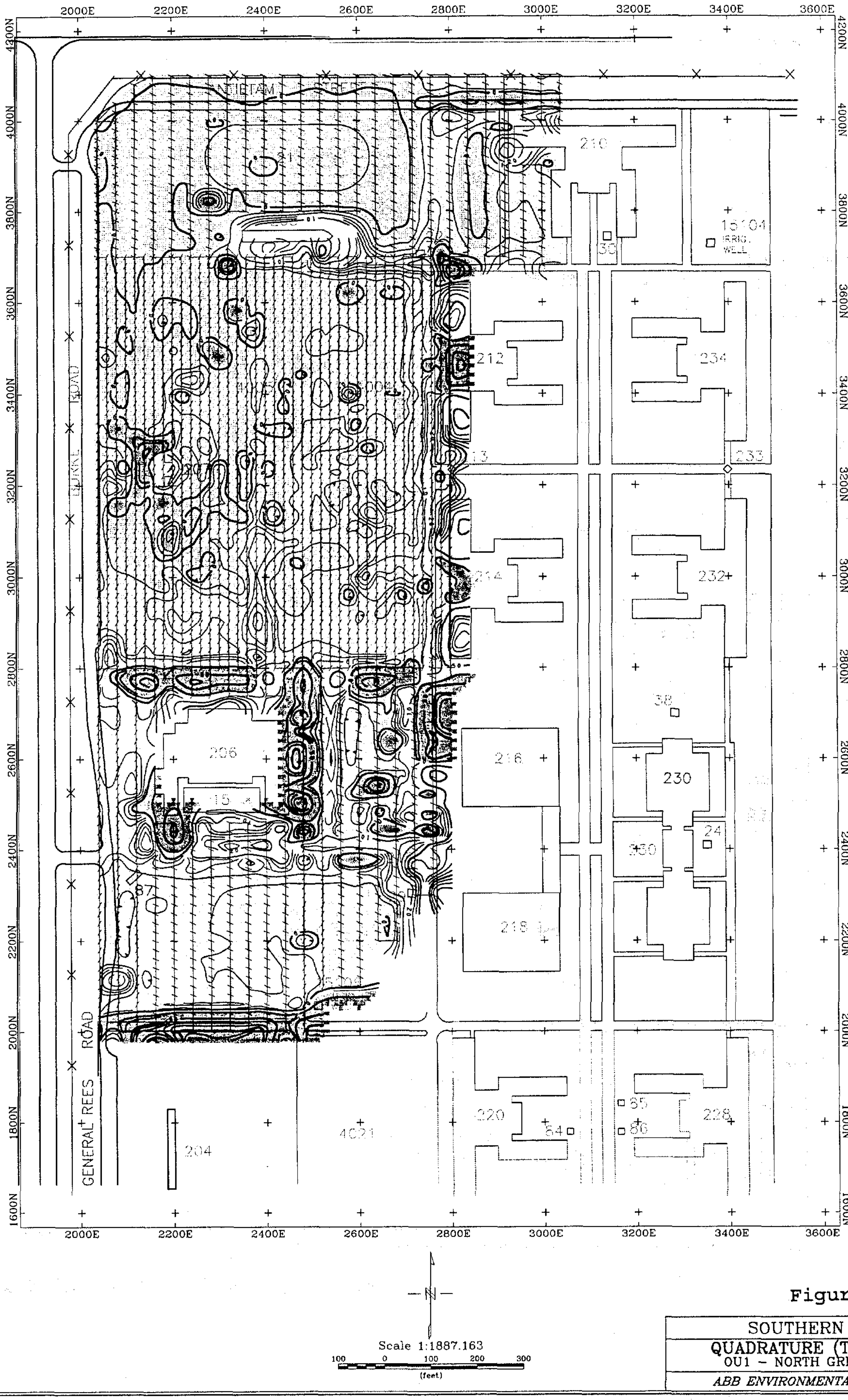

Figure 8

SOUTHERN DIVISION

QUADRATURE (TC) CONTOURS
OU1 - NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

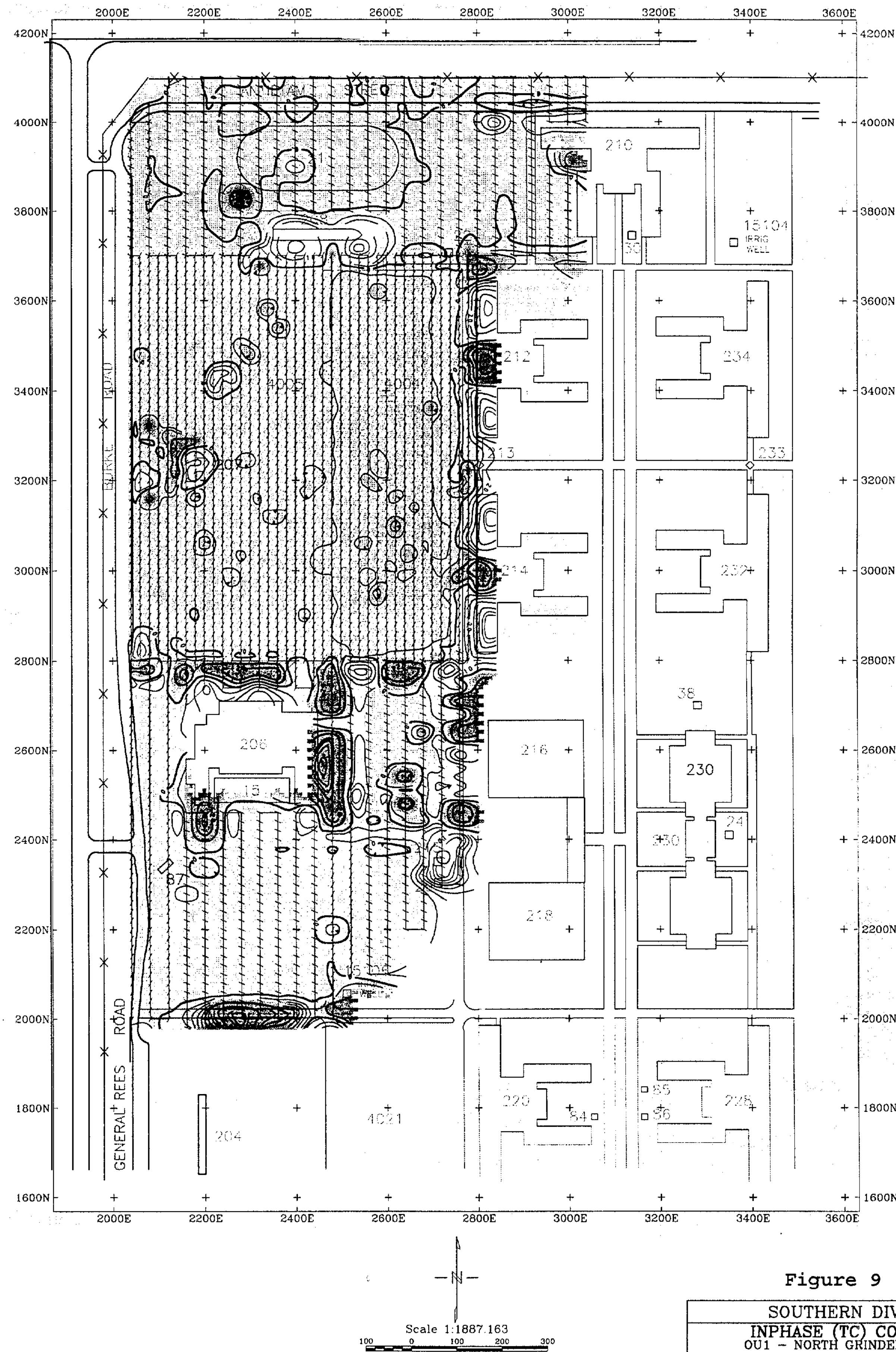

Figure 9

SOUTHERN DIVISION

INPHASE (TC) CONTOURS
OU1 – NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

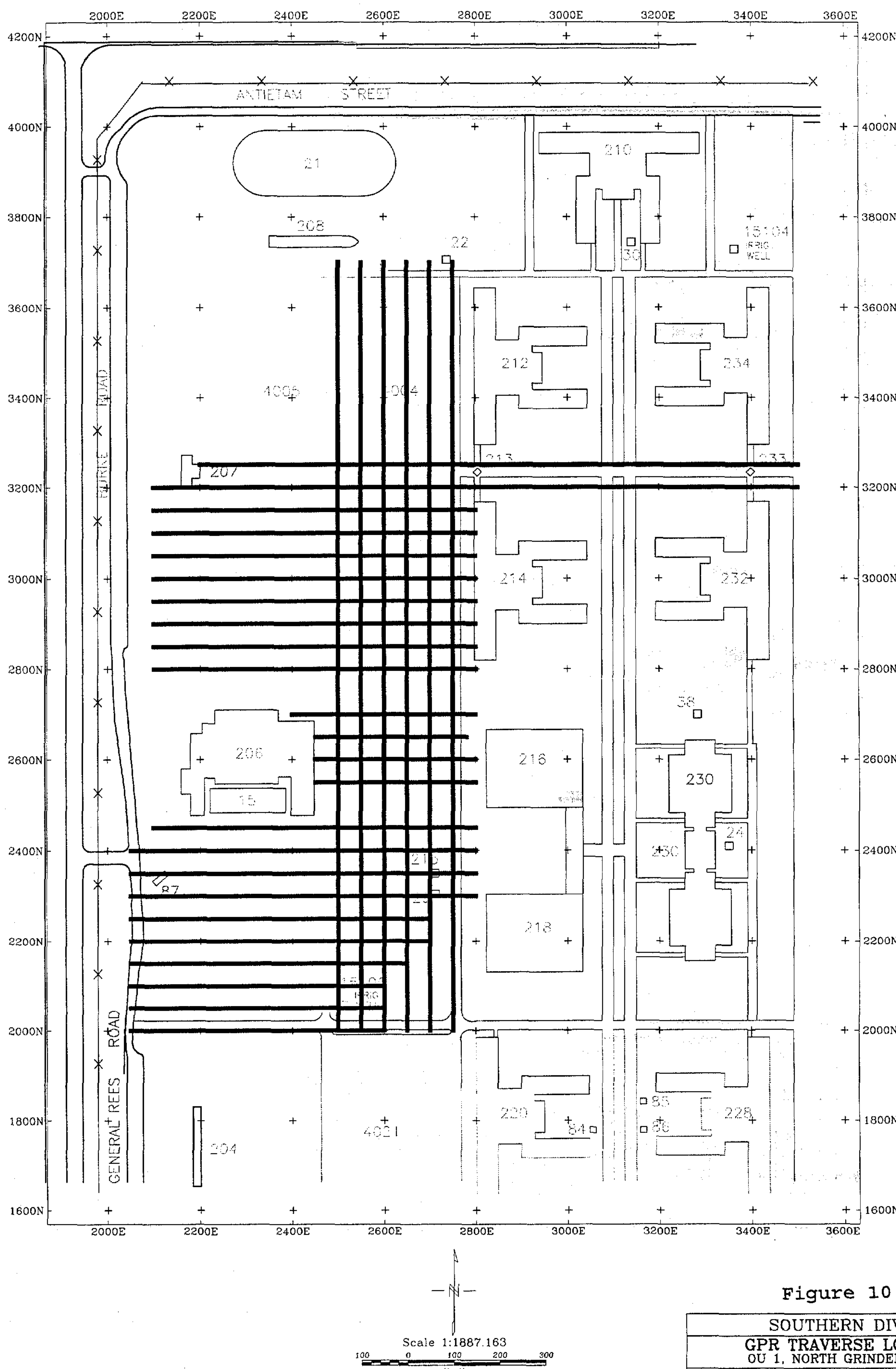

Figure 10

SOUTHERN DIVISION

GPR TRAVERSE LOCATIONS

OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

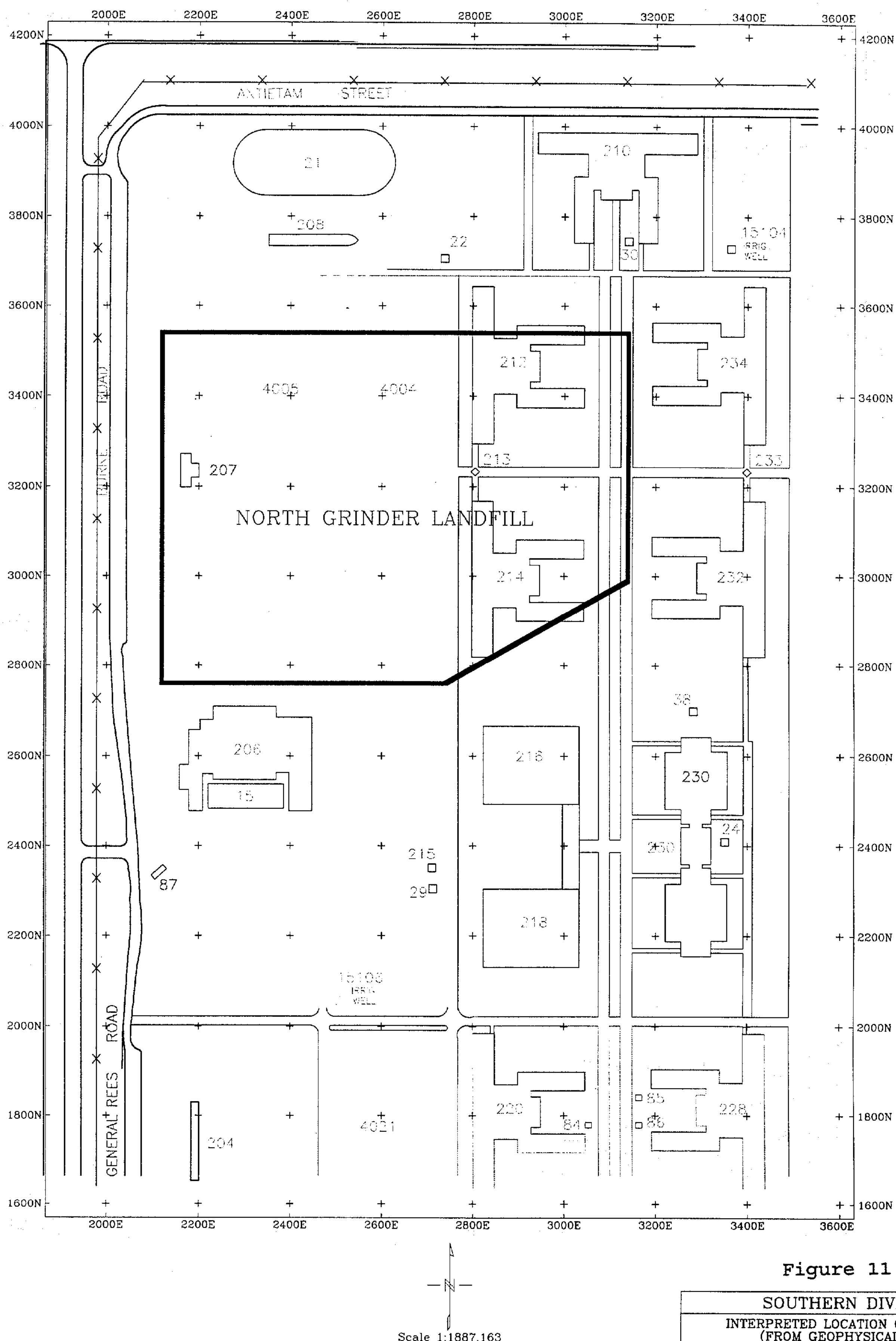

Figure 11

SOUTHERN DIVISION
INTERPRETED LOCATION OF LANDFILL (FROM GEOPHYSICAL DATA)
OU 1, NORTH GRINDER LANDFILL
ABB ENVIRONMENTAL SERVICES, INC.

ATTACHMENT A
GLOBAL POSITIONING SYSTEM

GPS, or Global Positioning System, refers to the constellation of 24 satellites deployed by the U.S. Department of Defense. The purpose for these satellites is to provide users on the ground (and in the air) with a means of accurately locating their position anywhere on the earth's surface. The height of the orbit of each satellite above the earth is in excess of 11,000 miles. Because the satellites are in such a high orbit, six to ten are in view at all times from every point on the earth's surface. A GPS receiver calculates its position by determining the distance between it and each satellite in view. The position is determined through triangulation.

The positions of each satellite in the constellation are known very accurately as a function of time. Thus, if one can determine the distance from one satellite, the position of the GPS receiver is defined by a sphere whose radius is the distance from satellite to receiver. If one also knows the distance from a second satellite, the position is defined by the intersection of two spheres, a circle. A third satellite would yield two points within that circle, and a fourth satellite would define one of those two points as unique.

Timing systems are essential in GPS, since the signals generated by each satellite travel at the speed of light toward earth. In fact, timing is accurate to within a tolerance of about 1 nanosecond (.000000001 seconds) or the amount of time it takes light to travel about 12 inches. The satellites each generate a coded signal (called a "pseudo-random" code) which is acquired by the receiver. At the same instant, the receiver generates a coded signal that is identical to that of each satellite in view. The receiver compares its code with that of each of the satellites in view to determine the time shifts (i.e., distances) from each of the satellites.

Errors in the calculations of a position can arise from a number of different sources, including

- minute timing errors by satellite or receiver);
- ephemeris errors due to incorrect prediction of the satellite position, information that is encoded in the satellite's signal information;
- errors due to unpredicted delays of the satellite signal as it passes through the earth's ionosphere and atmosphere;
- multipath errors due to reflections of the signal from objects near the receiver;
- S/A (Selective Availability), an operational mode imposed by the U.S. Department of Defense designed to "dither" or degrade the timing signal to deny our enemies access to accurate GPS signals for tactical reasons (e.g., missile targeting); and
- geometry considerations.

The largest error introduced into the calculation of position is that due to S/A.

Much of the cumulative error described above can be eliminated through the use of "differential" GPS. In differential GPS, a second GPS receiver is deployed over a known point near or in the area of interest. The second receiver is functioning as a "base station", while the first is known as the "rover". Since the satellites are so far away (11,000 miles) with respect to the distance between the base station and rover (generally less than, say, 250 miles), many of the errors introduced above are being seen equally by both receivers and will thus be canceled out.

If we record the base station data as a function of time and observe how the receiver "wanders" during the observation time while planted firmly over the known point, we can apply the diversion from the correct location to the rover data (also as a function of time) to "differentially correct" those data to eliminate much of the cumulative error described above. And if we also record a number of individual "fixes" (for, say, 1 to 10 minutes with 1 fix per second) at each observation point by the rover unit and average them prior to applying the differential correction, accuracy will be improved. And if we constrain the rover unit to only use the best geometry when selecting satellites[1], accuracy will be improved. And if we constrain the baseline (distance between rover and base station) to a distance less than, say 20 kilometers, accuracy will be improved.

Depending on the particular GPS system deployed, the number of recording channels, the number of fixes acquired at each position, the nature of the terrain and overhead vegetation, and whether or not differential corrections will be applied, one can expect errors[2] of from less than one to more than 100 meters. Differential techniques will generally reduce error to the range of less than one meter with reasonable data acquisition times (one to three minutes). And shorter baselines and better receiving units will improve accuracies into the decimeter range.

Improvements in GPS technology will continue to enhance accuracy in this highly competitive and rapidly evolving technology.

[1]PDOP, or Position Dilution of Position, is the parameter which is used to describe the geometry of a satellite constellation used to calculate a position. Generally, PDOP should be within the range of 4 to 6, values fairly easily achieved most of the time under ordinary circumstances.

[2]error is usually described by the term CEP, or circular error probability; i.e., the probability that one's computed position will lie within a sphere whose radius is "X"-meters.

ATTACHMENT B
MAGNETIC (TOTAL FIELD) MEASUREMENTS

INTRODUCTION

The magnetic method is a versatile, relatively inexpensive, geophysical exploration technique. Magnetic data can be acquired on land or water, or in the air. Aeromagnetic surveys and deep water marine studies are commonly used as a reconnaissance tool for evaluating hydrocarbon prospects. Land-based or coastal water marine magnetic surveys are usually done for evaluating shallow geologic structures in detail (e.g., shallow mineral deposits). These surveys have also been used successfully in locating manmade features such as in archeological prospecting.

More recently, the focus of national attention on the hazardous waste problem has prompted the routine use of magnetometers for locating repositories of buried (drummed) wastes. Locating and quantifying these materials is essential to any remediation effort, and magnetometer surveys can provide an extra measure of safety to those personnel involved in the clean-up activities.

EARTH MAGNETISM

Although the origin of the earth's magnetic field is not well understood, we do know that the earth behaves magnetically as if a large bar magnet were located near its center. The axis of this "magnet" is oriented at a small angle (about 18 degrees in New England) with respect to its axis of rotation. It is this angle that produces the small differences between "true" north and "magnetic" north; the angle is called the declination. The lines of magnetic force are nearly horizontal at the equator and nearly vertical at the poles. The angle between these lines of force and horizontal at any point on the earth's surface is known as the inclination.

The strength of the magnetic field also varies over the surface of the earth, and is stronger at the poles than at the equator. The strength of the field is approximately 60,000 gammas at the poles and 30,000 gammas at the equator (where 1 gamma equals 0.00001 Gauss).

The earth's magnetic field (sometimes referred to as its "ambient" field) is modified locally by both naturally occurring and manmade magnetic materials. Two types of magnetization contribute to this: induced and remanent. Induced magnetization refers to the ability of a material to act as a magnet itself, thereby enhancing the ambient field. The more the ambient field is enhanced by a material, the greater is the "magnetic susceptibility" for that material.

Remanent or permanent magnetization often predominates over induced magnetization in igneous rocks and metals. (Remanent refers to rocks, whereas permanent refers to metals.) Remanent or permanent magnetization is produced in materials that have been heated above the Curie point, allowing magnetic minerals to become aligned with the earth's ambient field before cooling. The remanent field direction is not, in general, parallel to the earth's present field. It may, in fact, act in the opposite direction. The remanent field combines vectorially with the ambient and induced field components, and any quantitative interpretation of magnetic data should consider this if such information is available.

INSTRUMENTATION

Although many types of magnetometers are available, the most widely used is the "proton precession" type. This device utilizes the precession of spinning protons of hydrogen atoms in a sample of hydrogen-rich fluid (e.g., kerosene, alcohol, or water) to measure the total magnetic field intensity.

Protons spinning in an atomic nucleus behave like tiny magnetic dipoles which can be aligned (polarized) by an external magnetic field. The protons are initially aligned parallel to the earth's field. A second, much stronger magnetic field is produced approximately perpendicular to the earth's field by introducing electric current through a coil of wire. The protons become temporarily aligned with this stronger field. When this stronger field is removed, the protons tend to realign themselves with the earth's field, causing them to precess about this direction at a frequency of approximately 2,000 Hz. The precessing protons will generate a small electric signal in the same coil used to polarize them with a frequency proportional to the total magnetic field intensity and independent of the coil orientation. By measuring the signal frequency, one can obtain the absolute value of the total earth's field intensity to an accuracy of 1 gamma or better. The total magnetic field value measured by the proton precession magnetometer is the net vector sum of the ambient earth's field and any local induced and/or remanent (permanent) perturbations.

FIELD TECHNIQUES

In the field, the operator should avoid any sources of high magnetic gradients such as would be caused by power lines, buildings, and any large iron or steel objects. The operator should also avoid carrying any unnecessary metal articles. Magnetic stations are established at an interval that reflects the nature of the survey and the magnetic gradients encountered.

During environmental investigations, a typical reconnaissance grid might start out at perhaps a 25-foot interval, and would be closed down to 5 or 10 feet in areas where additional detail is desired. If a total field survey is being conducted, base station readings should be taken frequently (every 30 minutes to 1 hour) to provide a check on any diurnal variations and magnetic storms that may occur during a survey. Typically, diurnal variations will not exceed a few tens of gammas, but magnetic storms may produce changes in the earth's field of thousands of gammas in a short period (on the order of hours). If survey requirements dictate, it may be prudent to establish a continuously recording magnetic base station to monitor diurnal variations. If a magnetic storm occurs, survey operations should cease until the storm is over.

A further refinement in magnetic studies can be achieved with the addition of vertical gradient measurements. This involves the simultaneous acquisition by two sensors of two values of the total field. The sensors are mounted on a staff that is held vertically during a measurement. A known distance (commonly one-half or one meter) separates the sensors on the staff. The vertical gradient value is derived by obtaining the difference between the total field values of the lower and upper sensors divided by the distance between them. Vertical gradient measurements tend to be more sensitive to the presence of near-surface metal objects than total field values alone.

There are commercially available magnetometers that record field data in an internal memory, which can be transferred at the completion of field activities to a personal computer for processing. These instruments can record the total field value, the vertical gradient, the time and date of the measurement, and the station location (input by the user), as well as a number of parameters that permit an evaluation of data quality. When vertical gradient measurements are the primary focus of a survey, the diurnal variation is inconsequential, because any variation affects the two sensors on the magnetometer sensor staff equally.

ATTACHMENT C
TERRAIN CONDUCTIVITY MEASUREMENTS

GENERAL

Terrain conductivity surveys, also referred to as EMI (electro-magnetic induction) surveys, have traditionally been used in mineral exploration for tracing conductive ore bodies (i.e., massive sulfides). More recently, conductivity surveys have been widely used for tracing conductive contaminant plumes in groundwater. Leachate from municipal landfills tends to be much more conductive than naturally occurring groundwater. Accordingly, the shape, extent, and relative impact of a plume can be studied with terrain conductivity surveys. Such surveys have also been successfully used in studying some organic contamination in soil and groundwater since the conductivity of most organic chemicals is much lower than naturally-occurring soils and groundwater.

DATA ACQUISITION

Since the instrument never comes in contact with the ground, data acquisition is more rapid than conventional, galvanic, earth resistivity surveys. However, quantification of conductivity data to yield a layered-earth solution is more difficult than with conventional earth resistivity. Two instruments commonly used in terrain conductivity surveys are the EM-31 and EM 34-3, both manufactured by Geonics, Ltd., in Mississauga, Ontario. These instruments, which have proven to be rapid-reconnaissance exploration tools, are used to assess the conductivity values for soil and rock materials. Although both instruments operate on the same principles, we will limit the following discussion to the EM-31.

PRINCIPLES

The instrumentation consists of a transmitter and receiver. When a measurement is made, the transmitter is energized by an alternating current that produces a magnetic field, designated as the primary field, H_p. This artificial magnetic field induces small electric currents to flow in the earth which, in turn, produce a secondary magnetic field, H_s, which is made up of two components: the quadrature phase and inphase components. The secondary magnetic field is related to the transmitter/receiver separation and to the operating frequency of the transmitter, both of which are selected by the operator. The ratio of the quadrature phase of the secondary field to the primary field (H_s/H_p) is linearly proportional to the terrain conductivity under most conditions. This ratio is measured by the receiver and converted into conductivity values in units of millimhos per meter. Field measurements may be recorded on a digital data logger, which is capable of recording simultaneously both the quadrature phase and in-phase components of the induced magnetic field. The quadrature-phase component, as stated earlier, gives the ground conductivity value in millimhos per meter. The in-phase component, used also for calibration, is significantly more sensitive to metallic objects and hence is useful for looking for buried tanks and drums, among other things. Data from the in-phase component may be thought of as being equivalent to a metal detector survey.

INTERPRETATION

Although it is difficult to define the thickness and "true" conductivity of individual subsurface layers, the instrument measures very precisely the "apparent" conductivity of a volume of underlying earth materials. The apparent conductivity value is comprised of the sum of the contributions from each layer that is "sampled" by the transmitter-receiver array. The volume (and therefore the depth) of earth materials sampled increases with increasing separation between the transmitter and receiver. The separation is fixed with the EM-31 at 3 meters and can be used in either the horizontal dipole or vertical dipole mode. Selection of the operational dipole mode depends on the depth of sampling desired, and the desired sensitivity of the instrument to materials at various depths, relative to the transmitter-receiver coil separation.

ATTACHMENT D
GROUND PENETRATING RADAR PROFILING

INTRODUCTION

The GPR technique uses high frequency radio waves to determine the presence of subsurface objects and structures. Energy is radiated downward into the subsurface from an antenna that is pulled slowly across the ground at speeds varying from about 0.25 to 5 mph, depending on the amount of detail desired and the nature of the target. The radio wave energy is reflected from surfaces where there is a contrast in the electrical properties of subsurface materials. These surfaces may be naturally occurring geologic horizons (e.g., soil layers, changes in moisture content, voids and fractures in bedrock) or manmade (e.g., buried utilities, tanks, drums). The reflected energy is processed and displayed as a continuous strip chart recording of distance versus time (where time can be thought of as proportional to depth). The depth of penetration of a GPR system is highly site-specific, and depends (among other factors) on (1) the soil types at the site (clean sands are best), (2) moisture conditions (dry is best), and (3) the frequency of the antenna (the lower the frequency, the deeper the penetration, and the less the resolution capability).

Typical applications for GPR include delineating the boundaries of buried hazardous waste materials and the perimeters of abandoned landfills; finding steel reinforcement bars and voids in concrete structures; recording the depth of geological interfaces, bedrock, and coal seams; locating and mapping buried utilities; bottom and shallow sub-bottom profiling on lakes; and determining glacial ice stratification and thickness.

PRINCIPLES

The radar system consists of a control unit, an antenna assembly (transmitter/receiver), and a recording device for analog field recordings. A tape-recording unit may also be present for further data processing after field activities are completed. The antenna transmits electromagnetic (EM) pulses of short duration into the ground. The pulses are reflected from geologic or manmade surfaces and are picked up by the receiver, which transmits the signals to the control unit for processing and analog display. Shallow objects appear near the top of the strip chart recording (less time elapsed between the outgoing pulse and the return of reflected energy), whereas deeper objects appear farther down the recording (more time elapsed). The time required for the EM pulse to traverse the path down to and back from the reflecting medium is measured in nanoseconds (one nanosecond = (1×10^{-9} seconds). The two-way travel time is proportional to the depth of burial of the reflecting medium and is dependent on the dielectric properties of the medium through which the EM pulse travels. The dielectric properties of a medium are related to the moisture content and composition of a material.

The propagation velocity of the EM pulse is determined by the relative dielectric permitivity of the material (e_r) through which the pulse travels. The relative dielectric permitivity is a measure of the degree to which a medium can resist the flow of the EM pulse: the higher the relative permitivity, the lower the resistance to flow, and vice versa. For most earth materials and rocks, the relative dielectric permitivity does not exceed 10 and is always greater than unity, the value for a vacuum. Table C-1 gives typical permitivity values for commonly encountered materials. The dielectric permitivity is related to the propagation velocity by the formula

$$(1) \quad e_r = (c/V_m)^2,$$

where "c" is the propagation velocity in free space ($3x10^8$ meters per second or approximately 1 foot per nanosecond), and V_m is the propagation velocity through a material. It follows that

$$\surd(e_r) = c/V_m \text{ or } 1/V_m = (e_r)^2/c.$$

Since c is approximately equal to 1 ft/ns, then

$$(2) \quad 1/V_m \text{ is approximately equal to } \surd(e_r),$$

where units are in ns/ft (one-way travel time). Formula (2) gives a method for estimating the propagation velocity for a medium (and therefore the depth to a reflecting horizon) if the soil conditions are known. If they are unknown or their properties cannot be estimated accurately enough, a reflector of known depth can often be used to calibrate the GPR recordings to site conditions.

Figures D-1 through D-3 present sections of typical GPR recordings. They have been annotated for the convenience of the reader to call out significant features.

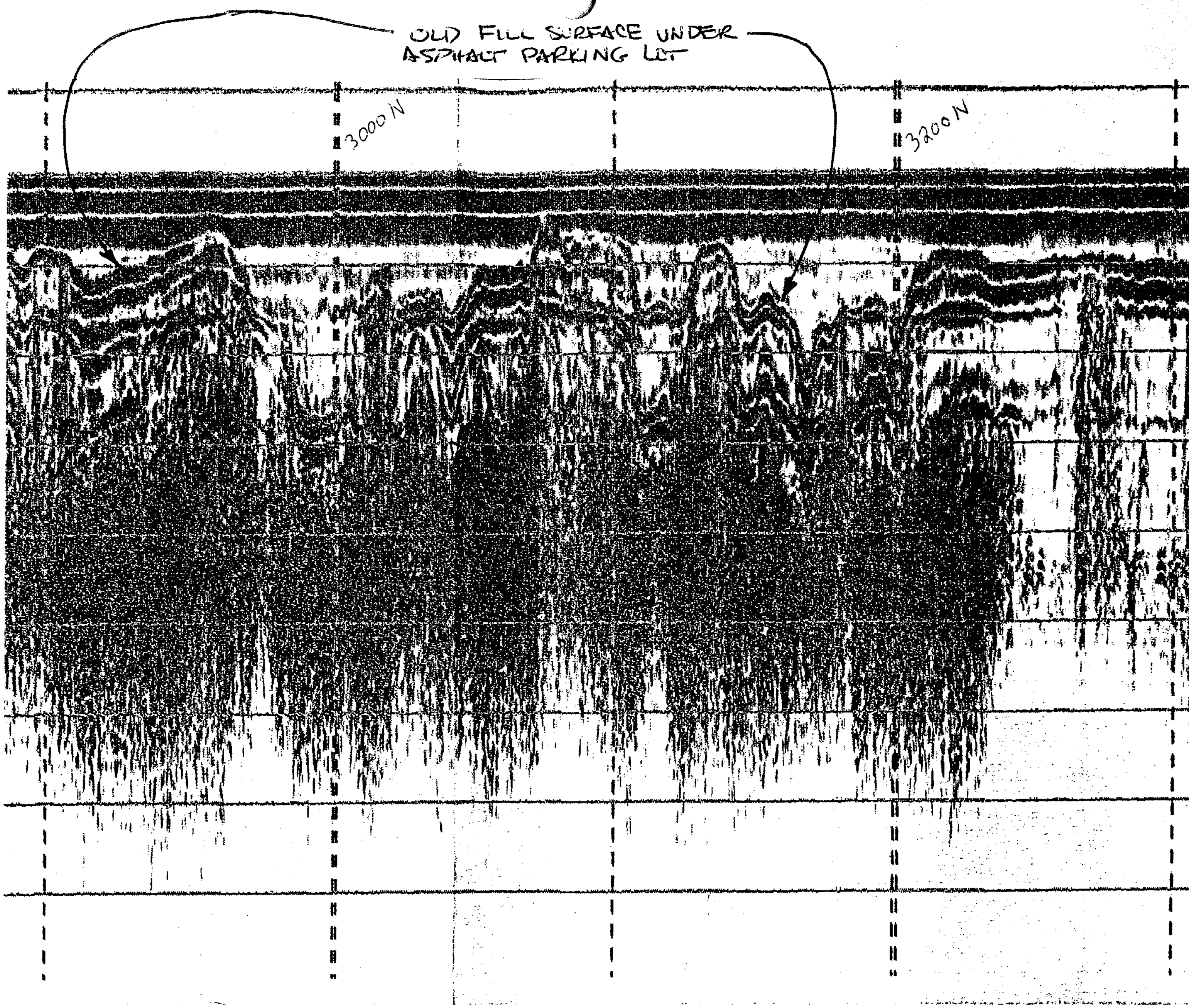

Figure D-1

NOTES:
1) Horizontal lines represent vertical increments of 5 nanoseconds or approximately 1 foot.
2) Vertical (dashed) lines represent horizontal increments of 100 feet along a traverse.

SOUTHERN DIVISION
GPR RECORDING LINE 2600 EAST (2900 NORTH TO 3300 NORTH)
OU 1, NORTH GRINDER LANDFILL
ABB ENVIRONMENTAL SERVICES, INC.

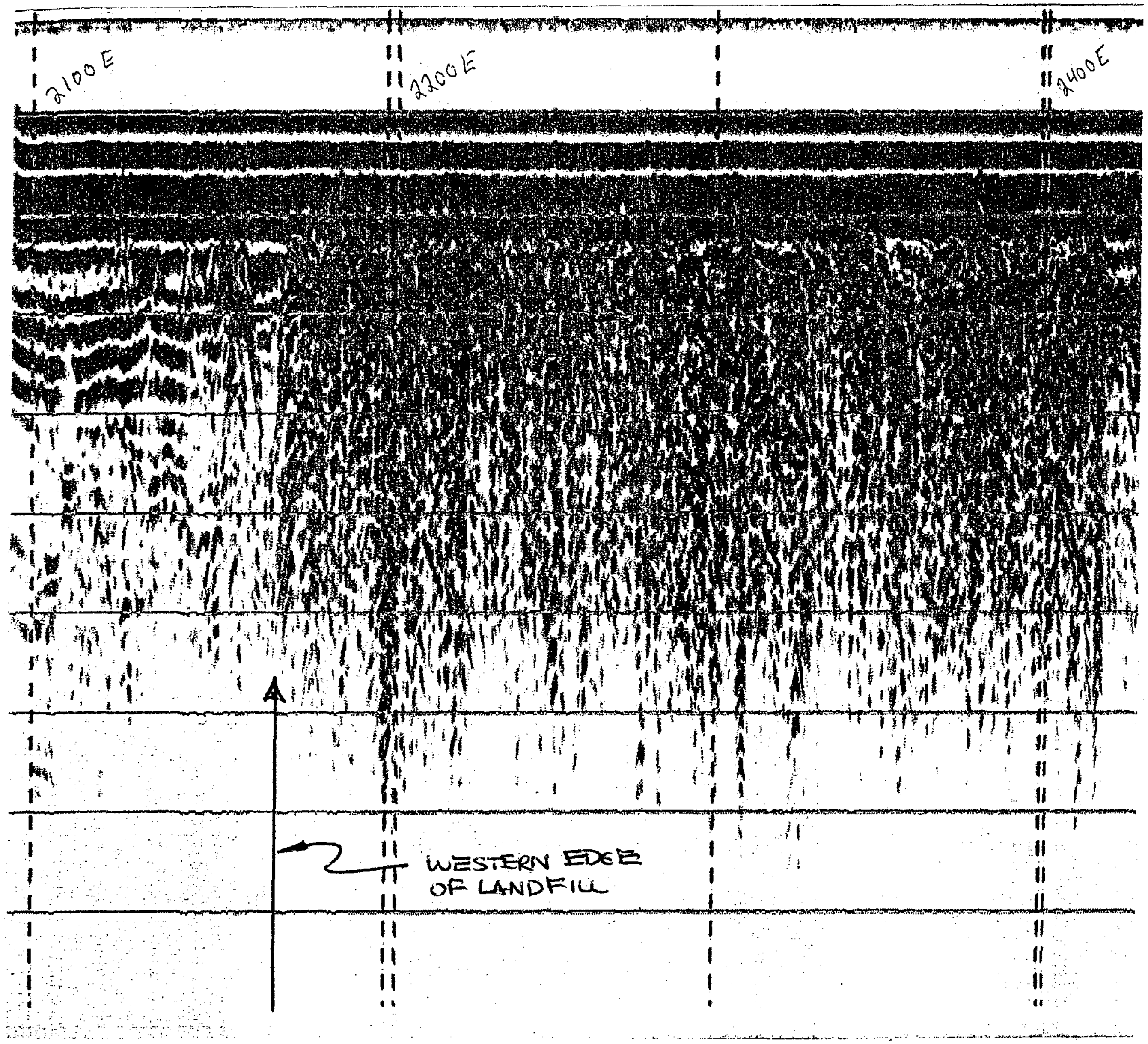

Figure D-2

SOUTHERN DIVISION

GPR RECORDING

LINE 2850 NORTH

(2100 EAST TO 2400 EAST)

OU 1, NORTH GRIN[illegible] [illegible]ANDFILL

ABB ENVIRONMENTA[illegible] [illegible]VICES, INC.

NOTES:

1) Horizontal lines represent vertical increments of 10 nanoseconds or approximately 2 feet.

2) Vertical (dashed) lines represent horizontal increments of 100 feet along a traverse.

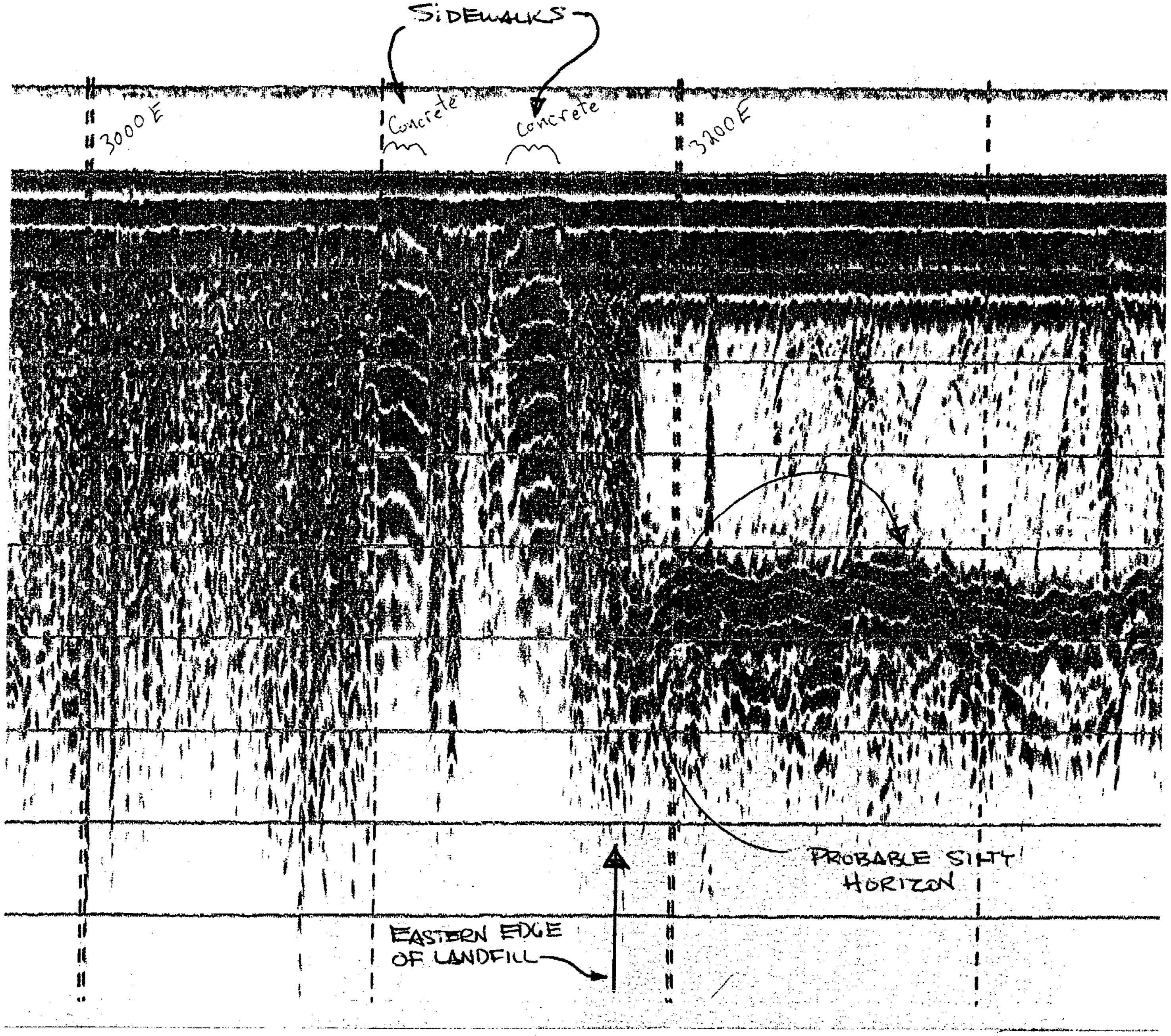

Figure D-3

NOTES.
1) Horizontal lines represent vertical increments of 10 nanoseconds or approximately 2 feet.
2) Vertical (dashed) lines represent horizontal increments of 100 feet along a traverse.

SOUTHERN DIVISION

GPR RECORDING
LINE 3250 NORTH
(3000 EAST TO 3300 EAST)

OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

TABLE D-1
APPROXIMATE VHF ELECTROMAGNETIC PROPERTIES OF VARIOUS MATERIALS*

MATERIAL	RELATIVE DIELECTRIC PERMITTIVITY	PULSE VELOCITY (NS/FT)
air	1	1
freshwater	81	9
seawater	81	9
sand (dry)	4-6	2.0-2.4
sand (saturated)	30	5.5
silt (saturated)	10	3.1
clay (saturated)	8-12	2.8-3.3
average "dirt"	16	4.0
dry sandy coastal land	10	3.1
marshy forested flat land	12	3.5
rich agricultural land	15	3.9
pastoral land, hilly, forested	13	3.6
freshwater ice	4	2.0
permafrost	4-8	2.0-2.9
granite (dry)	5	2.2
limestone	7-9	2.6
concrete	6.4	2.5
asphalt	3-5	1.7-2.5

* Modified from Geophysical Survey Systems, Inc.

APPENDIX B

GROUNDWATER SCREENING RESULTS
DIRECT PUSH TECHNOLOGY SURVEYS

TECHNICAL MEMORANDUM
GROUNDWATER SCREENING
DIRECT PUSH TECHNOLOGY SURVEYS

OU 1, NORTH GRINDER LANDFILL

NAVAL TRAINING CENTER, ORLANDO
ORLANDO, FLORIDA

Unit Identification Code (UIC): N65928

Contract No. N62467-89-D-0317

Prepared by:

ABB Environmental Services, Inc.
2590 Executive Center Circle, East
Tallahassee, Florida 32301

Prepared for:

Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29418

Barbara Nwokike, Code 1873, Engineer-in-Charge

July 1995

TECHNICAL MEMORANDUM
GROUNDWATER SCREENING
DIRECT PUSH TECHNOLOGY SURVEYS

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JULY 1995

INTRODUCTION

The remedial investigation (RI) began at the North Grinder Landfill at the Main Base, NTC, Orlando on March 13, 1995 (Figure 1). The landfill outline indicated on Figure 1 was constructed from historical aerial photographs. Initial field activities consisted of establishing a survey grid upon which to reference future investigations, followed by geophysical surveys to more accurately determine the location of the Landfill than is possible from historical accounts and aerial photographs. The interpreted location of the North Grinder Landfill from geophysics is presented as Figure 2. Geophysical surveys were followed by direct push technology (DPT) surveys to map any groundwater contamination produced by rainwater infiltration and groundwater flow through landfill debris which may intersect the water table. Water samples were obtained from depths up to 80 feet below land surface (bls) and were analyzed on a field gas chromatograph (GC), an HNU Model 311, for the presence of volatile organic compounds (VOCs). Several samples were also submitted to an offsite laboratory for volatile organics analysis using CLP methodology.

This memorandum documents the particulars of the DPT survey and the rationale for selection of the monitoring well clusters.

1.0 DPT SURVEYS

DPT Surveys at OU 1 consisted of the use of two technologies to map potential groundwater contamination in the vicinity of the North Grinder Landfill and to thus aid in the selection of the best locations for permanent well clusters for verification of groundwater conditions both up gradient and down gradient of the landfill. A TerraProbe^{sm} survey was completed to obtain shallow and intermediate (up to 30 feet bls (below land surface) groundwater samples. A more sophisticated cone penetrometer test (CPT) survey was then conducted in which stratigraphic logs at 17 locations to depths of up to 80 feet bls were developed. In addition, the CPT survey permitted collection of groundwater samples to similar depths.

1.1 TERRAPROBE^{SM} SURVEY. A total of 55 TerraProbe^{sm} locations were completed between April 12 and April 26, 1995 (Figure 3). 116 water samples were taken for field GC analysis (on an HNU 311 gas chromatograph with photoionization detector) during this program from one or more depths. Table B-1 summarizes the locations, depths, and analytical results of these samples. Also shown on Table B-1 are those locations which were subsequently sampled during the CPT program. Samples were screened in the field with a portable gas chromatograph.

TerraProbe^{sm} results were used to plan the locations for the CPT program.

1.2 CONE PENETROMETER TEST SURVEY. The CPT program began on May 3 and was completed on May 25, 1995. During the CPT program, a total of 17 cone tests were completed (Table B-1). The cone tests permitted an evaluation of local stratigraphy and the best depths from which to obtain water samples. A total of 35 water samples were obtained during this program and screened with a portable field gas chromatograph. Table B-1 summarizes the locations, depths, and analytical results of these samples. Ten samples were sent to an offsite laboratory for volatile organics analysis using CLP methodology. These results are shown on Table B-2.

2.0 DISCUSSION OF RESULTS

Included on Table B-1 are the Florida Primary Drinking Water Standards (FPDWSs) for the various VOCs which were analyzed during the field screening investigation. The highest contaminant levels for these compounds were benzene and tetrachloroethylene (PCE). Benzene was detected in sample U1P01902 at a concentration of 9.7 $\mu g/\ell$ (vs. an FPDWS of 1 $\mu g/\ell$), and 7.5 $\mu g/\ell$ were detected in U1P05002, 3.7 $\mu g/\ell$ in U1P03901, and 1.2 $\mu g/\ell$ in U1P03702; where "U1" in the sample identifier signifies OU 1, North Grinder Landfill; "P" signifies Direct Push Technology; "019" is location number 19; and "02" is sample number 2 from that location. Sample U1P01902 had total BTEX of 26.5 $\mu g/\ell$. There is a UST near this location which services Building 206 which may be the source for benzene and BTEX contamination in this area.

PCE was detected in U1P00401 at a concentration of 7.3 $\mu g/\ell$ (vs. an FPDWS of 3 $\mu g/\ell$), 5.2 $\mu g/\ell$ were detected in U1P00202, 5.0 $\mu g/\ell$ in U1P00302, and 3.3 $\mu g/\ell$ in U1P00603.

The ten confirmation samples sent to the CLP laboratory for volatile organics analysis did not have any positive hits on compounds analyzed on the field GC, although there were detections of acetone (interpreted to be a laboratory or sampling artifact) and carbon disulfide.

Figure 4 presents the shallow (less than 25 feet below land surface) DPT screening results as total VOCs in $\mu g/\ell$. Figure 5 presents the intermediate depth (greater than 25 feet bls) DPT screening results. Figure 6 presents total VOCs (maximum concentration plotted without regard to depth). From this map, two areas of minor VOC contamination have been interpreted.

Monitoring well location selection was based on the DPT results and on groundwater flow data developed during the initial stages of the RI investigation. The monitoring well locations as presented to and approved by the BCT on June 8 and 9, 1995 are shown on Figure 7. The nine monitoring well clusters were installed around the perimeter of the former landfill with several locations biased toward the two zones of minor VOC contamination defined by DPT results. Two of the clusters are upgradient of the landfill, and the remaining seven clusters are located along the west, north and east boundaries of the landfill to form a "fence" downgradient from the landfill for the purpose of long-term monitoring.

Groundwater contours were developed from the existing three monitoring wells installed in 1986 during the Verification Study by Geraghty & Miller (a fourth well installed at that time is no longer accessible). Three piezometers (PZ-1 through PZ-3) were installed by ABB-ES to supplement the three existing monitoring wells. Figure 8 presents the groundwater contours in the vicinity of OU 1 from groundwater level data obtained on June 7, 1995.

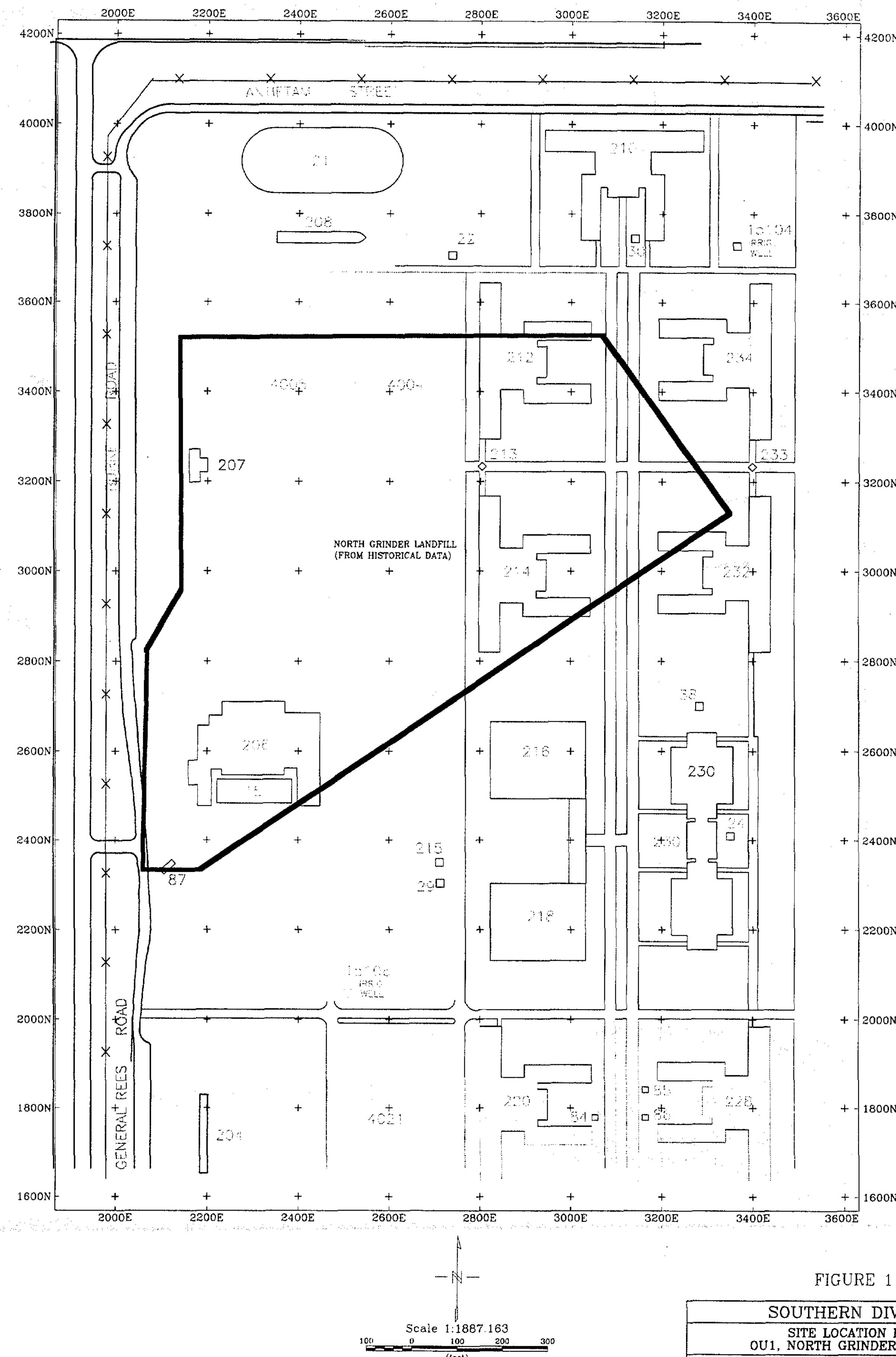


FIGURE 1

SOUTHERN DIVISION

SITE LOCATION PLAN
OU1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

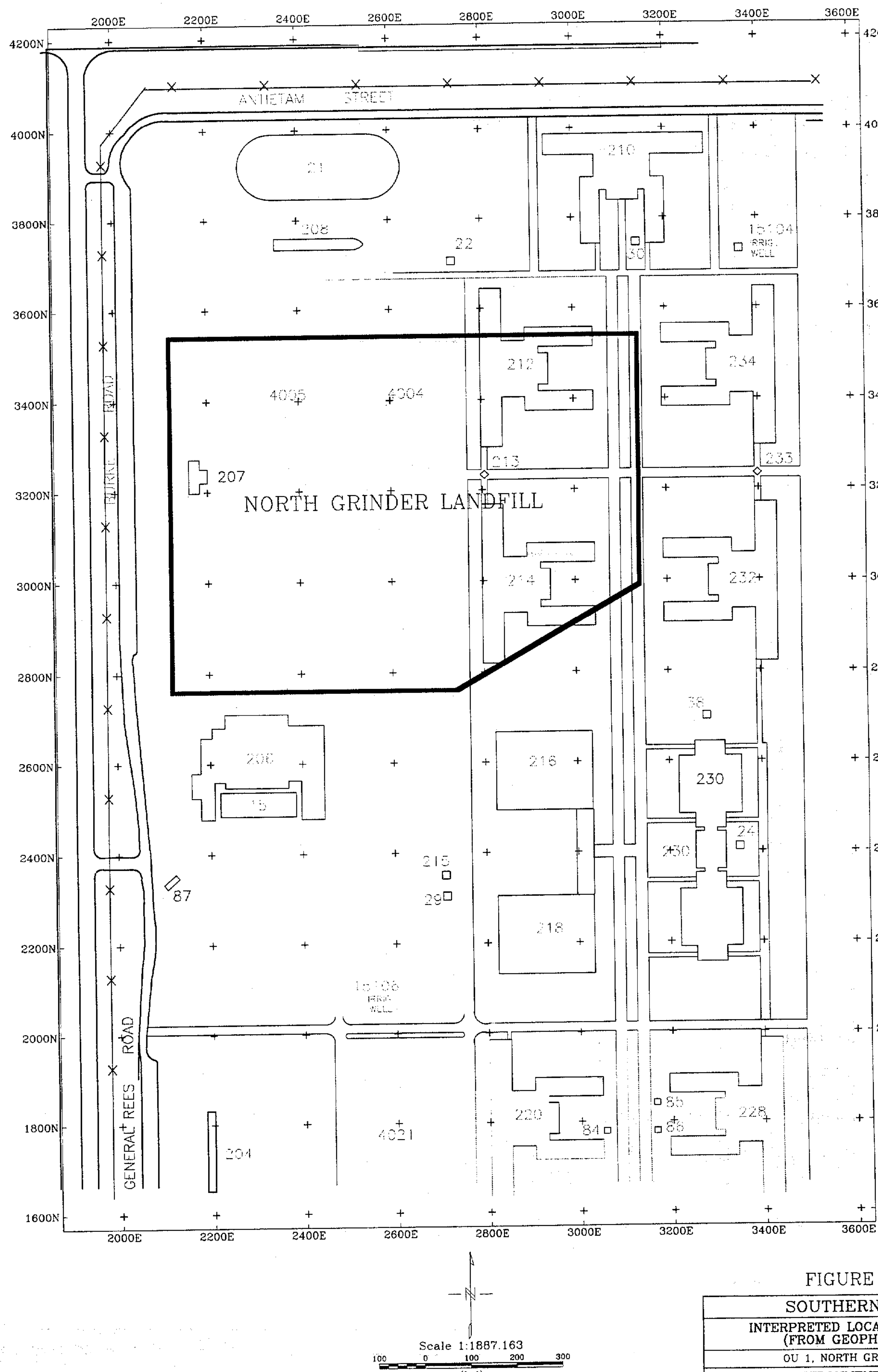


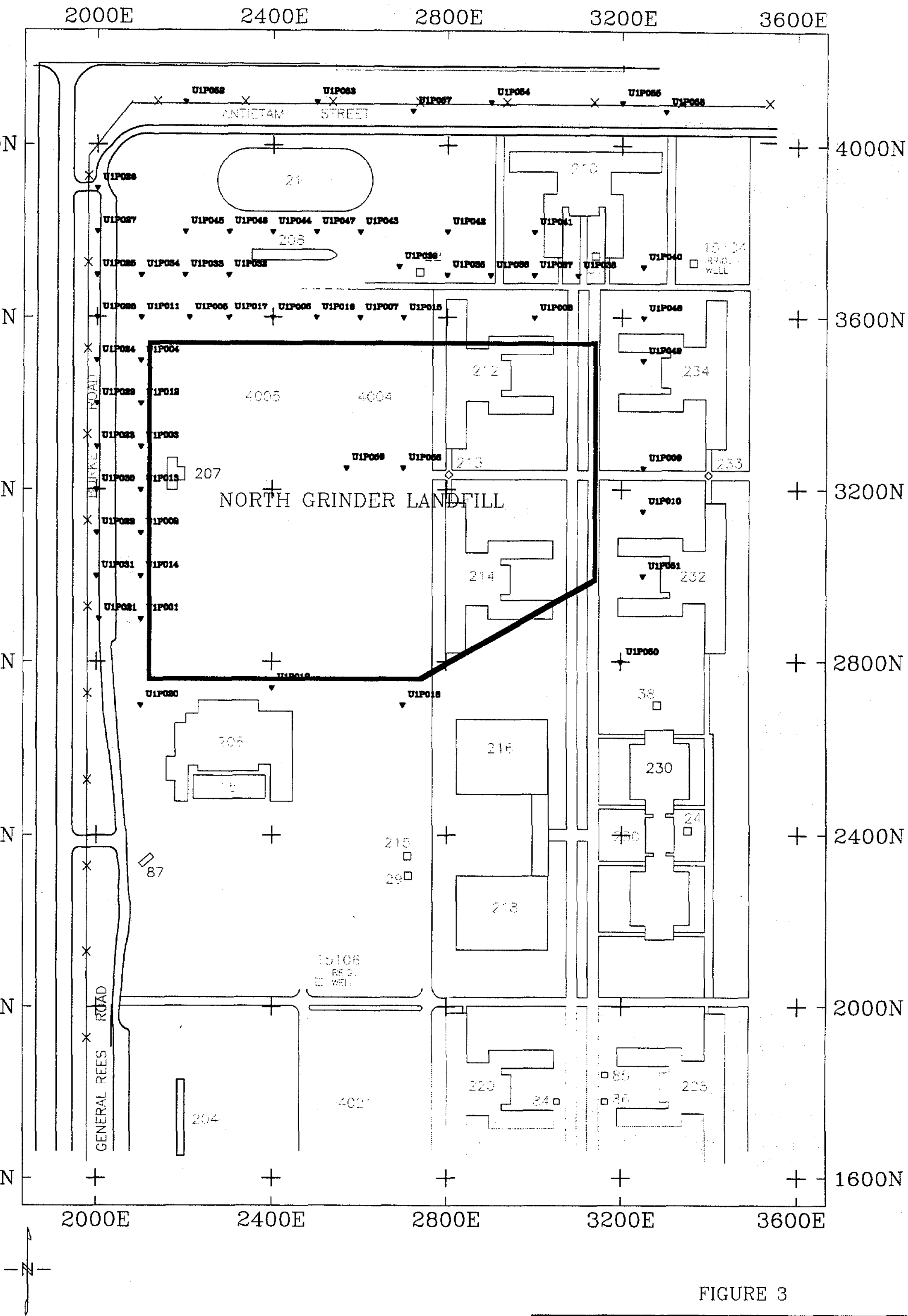
FIGURE 2

SOUTHERN DIVISION

INTERPRETED LOCATION OF LANDFILL (FROM GEOPHYSICAL DATA)

OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.



Scale 1:4004.463

250 0 250

(feet)

FIGURE 3

SOUTHERN DIVISION

TERRAPROBE AND CPT LOCATIONS
DPT SURVEYS
OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

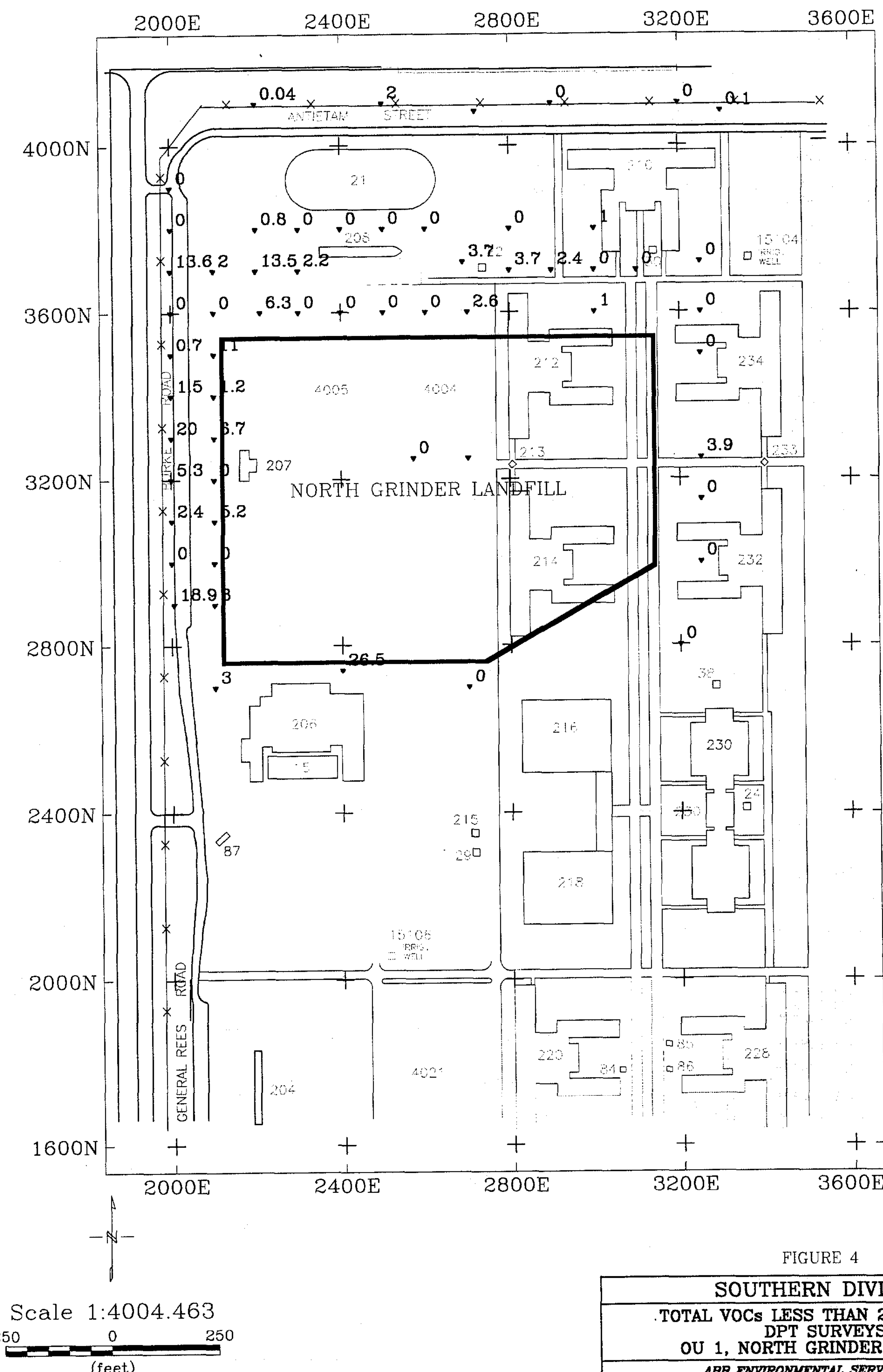


FIGURE 4

SOUTHERN DIVISION

TOTAL VOCs LESS THAN 25 FEET BLS
DPT SURVEYS
OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

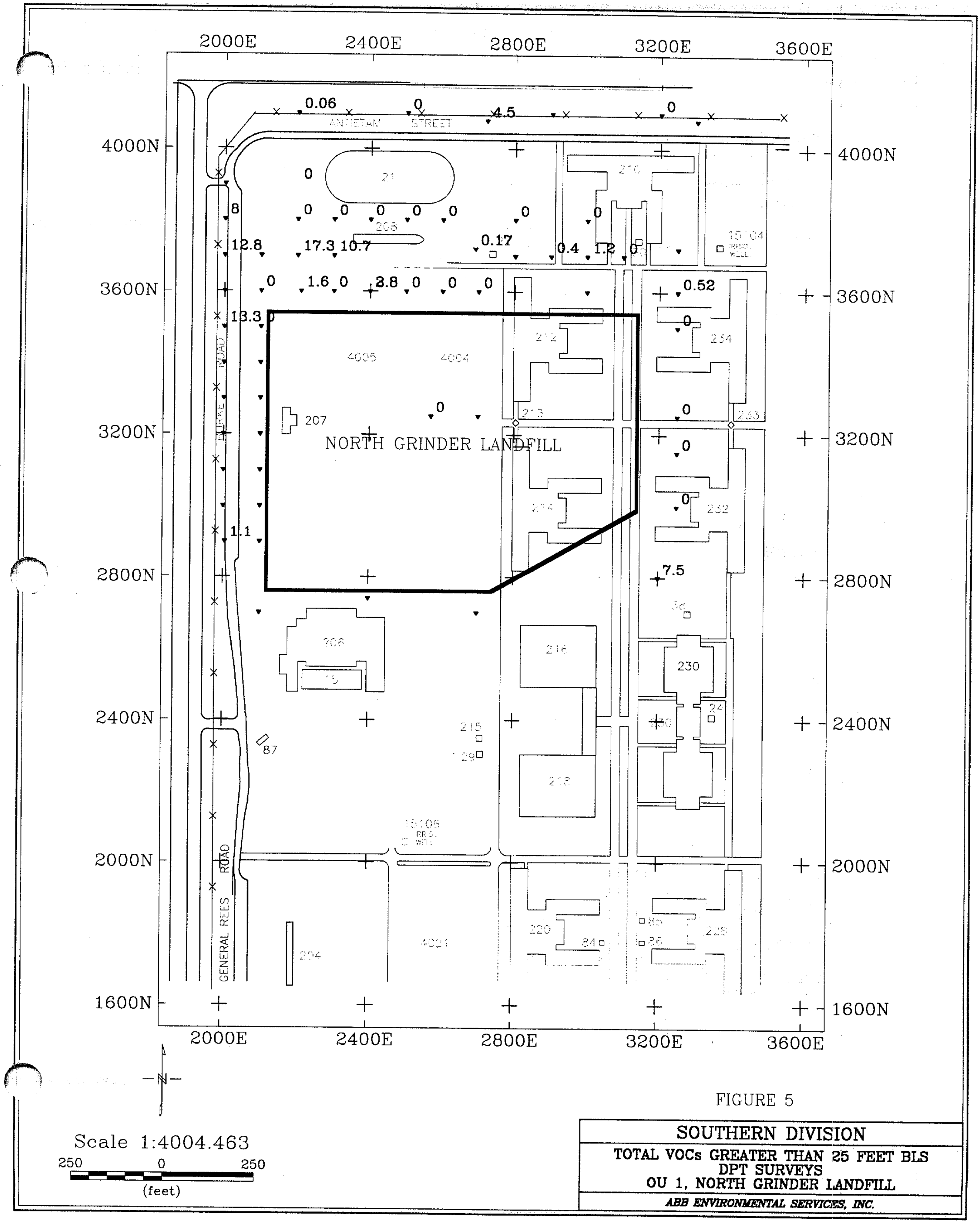


FIGURE 5

SOUTHERN DIVISION

TOTAL VOCs GREATER THAN 25 FEET BLS DPT SURVEYS OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

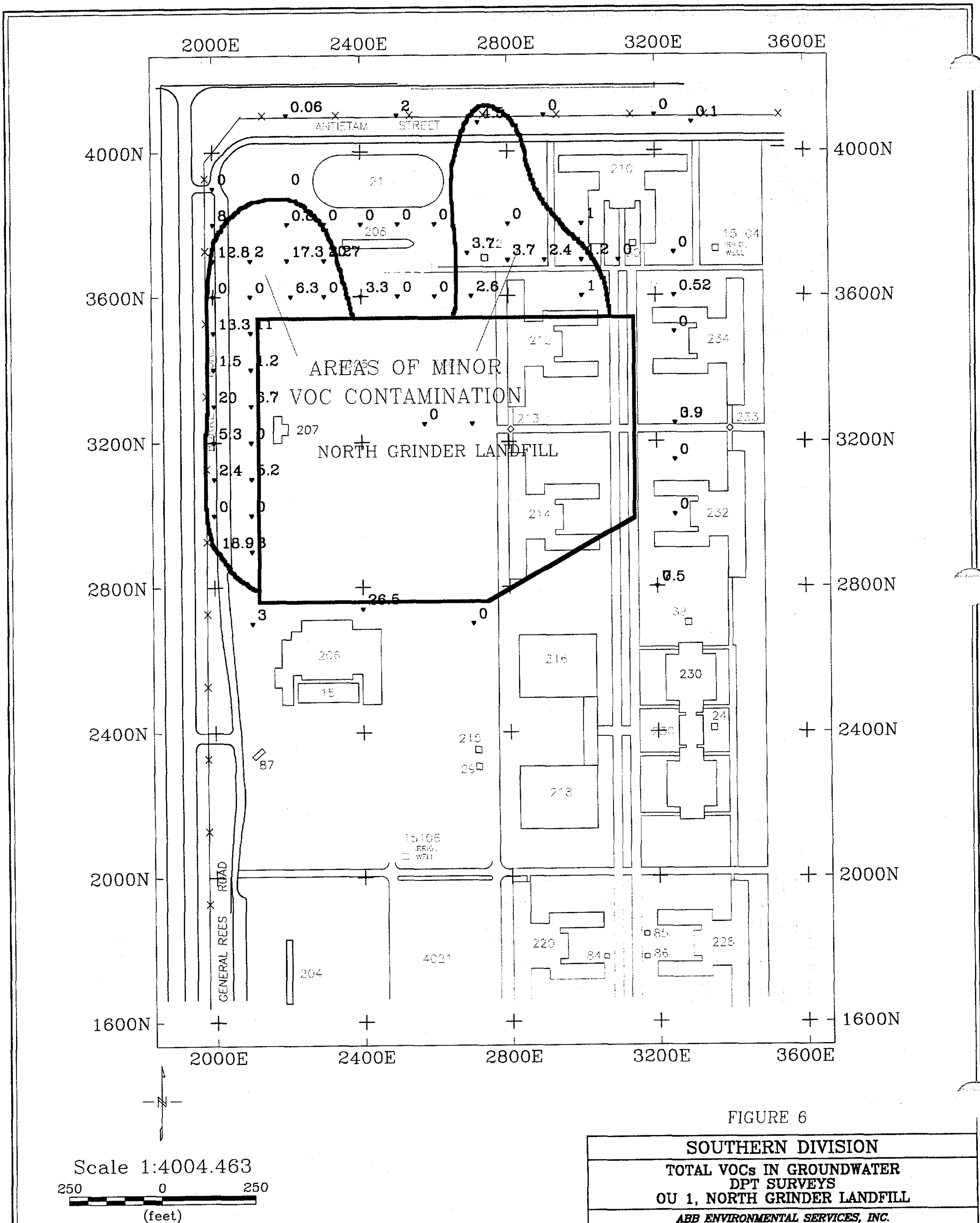
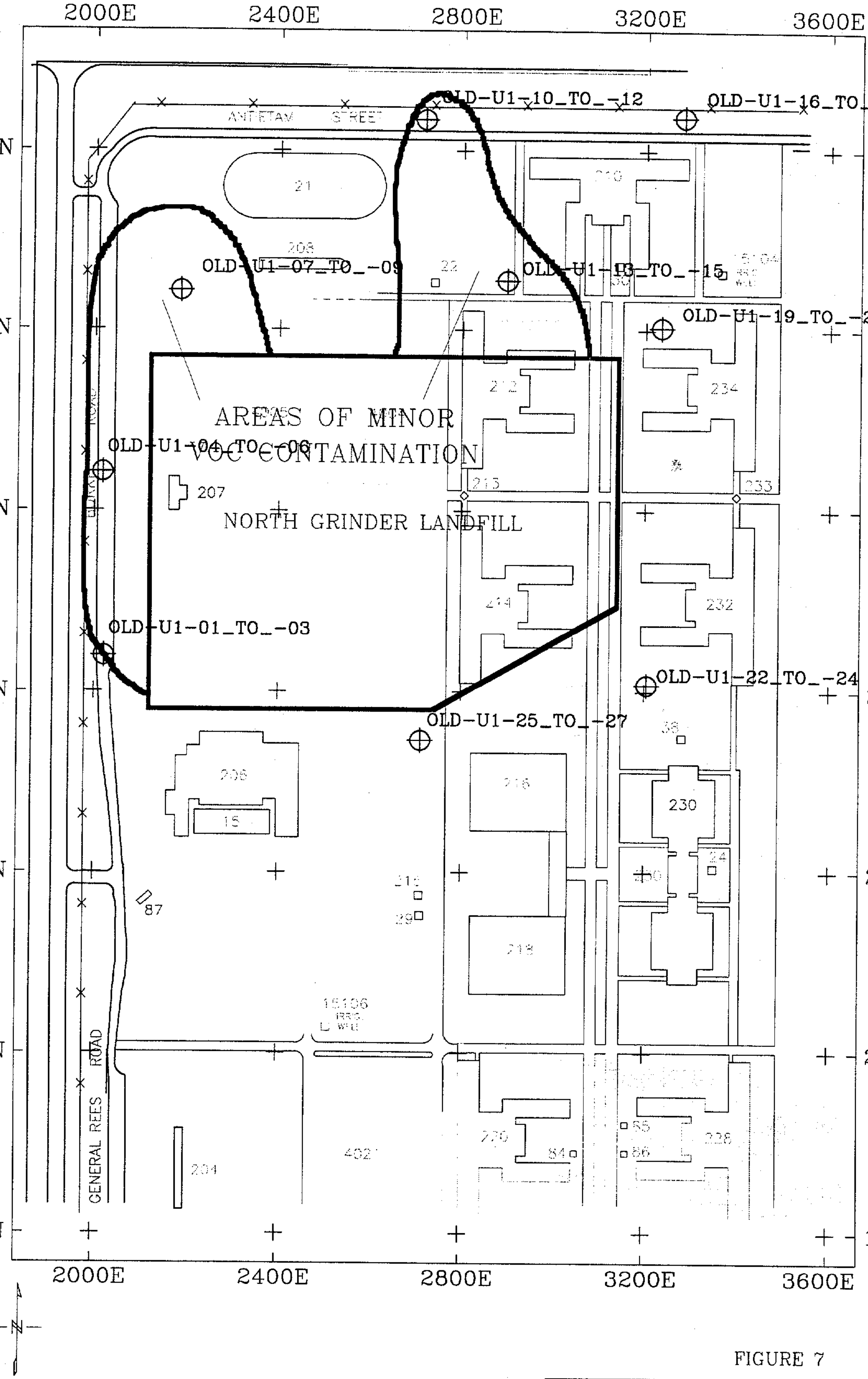


FIGURE 6

SOUTHERN DIVISION

TOTAL VOCs IN GROUNDWATER
DPT SURVEYS
OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.



Scale 1:4004.463

250 0 250

(feet)

FIGURE 7

SOUTHERN DIVISION

MONITORING WELL LOCATIONS (BASED ON DPT SURVEY DATA) OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

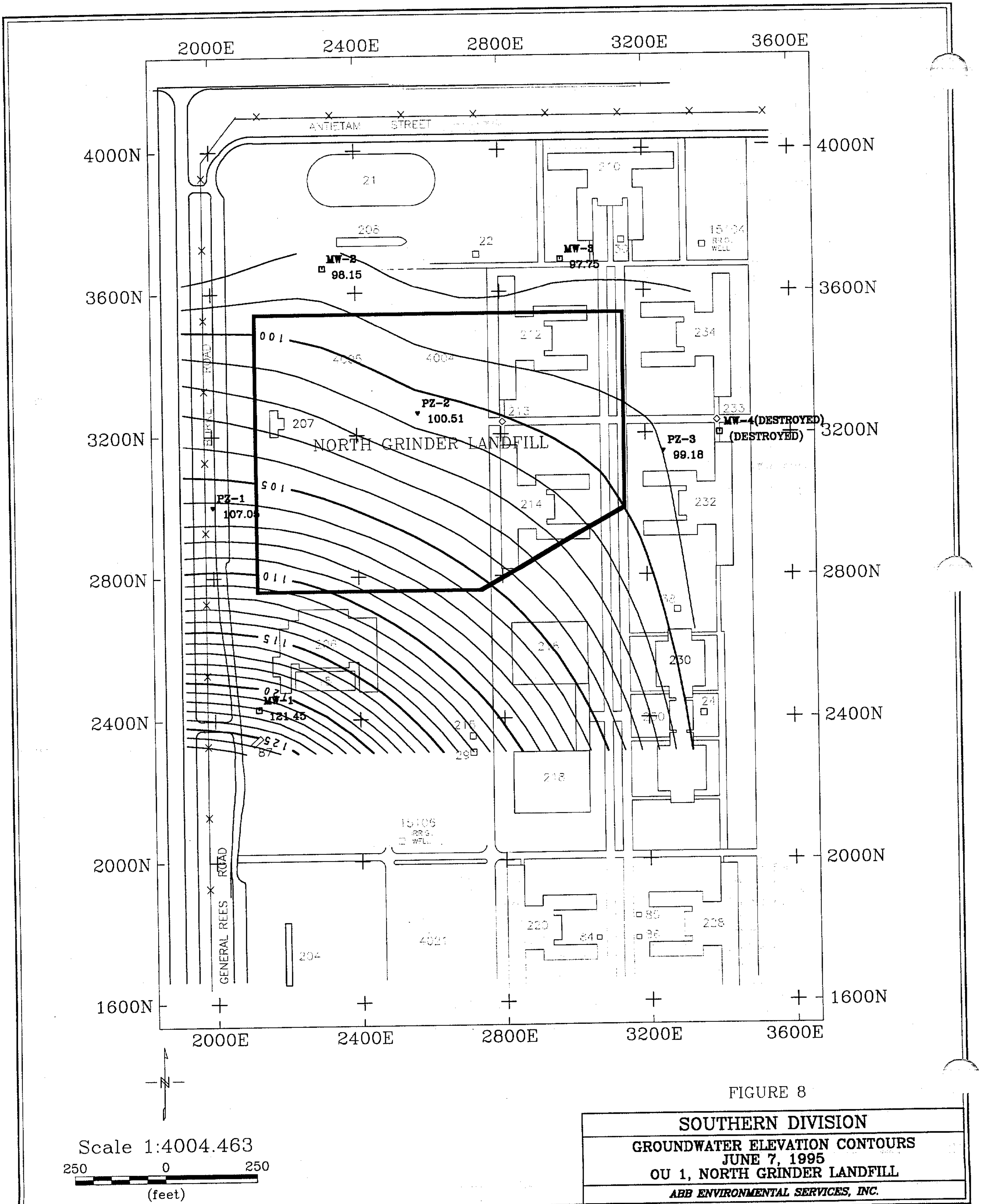


FIGURE 8

SOUTHERN DIVISION

GROUNDWATER ELEVATION CONTOURS
JUNE 7, 1995
OU 1, NORTH GRINDER LANDFILL

ABB ENVIRONMENTAL SERVICES, INC.

TABLE B-1
FIELD GC RESULTS
TERRAPROBE/CONE PENETROMETER PROGRAM
OU 1, NORTH GRINDER LANDFILL

SAMPLE ID	DEPTH (BLS)	DATE/TIME	EASTING	NORTHING	BENZENE (FPDWS=1)	TOLUENE (FPDWS=1000)	ETHYLBENZENE (FPDWS=700)	M-,P-XYLENE (FPDWS=10,000)	O-XYLENE (FPDWS=10,000)	TCE (FPDWS=3)	PCE (FPDWS=3)	DCA (FPDWS=3)	ΣBETX	Σchlor	ΣVOCs	DPT SAMPLING LOCATIONS	CPT LOCATIONS
U1P00101	15	4/12/95 15:00	2100	2900													
U1P00102	18.5	4/12/95 15:35	2100	2900							3.0			3.0	3.0		
U1P00201	16	4/12/95 17:00	2100	3100													
U1P00202	24	4/12/95 17:20	2100	3100							5.2			5.2	5.2		
U1P00301	16	4/13/95 8:55	2100	3300					5.0				5.0		5.0		
U1P00302	22	4/13/95 9:10	2100	3300				1.7			5.0		1.7	5.0	6.7		
U1P00401	16	4/13/95 10:05	2100	3500		3.0					7.3		3.0	7.3	10.3		
U1P00401D	16	4/13/95 10:05	2100	3500		5.0					6.0		5.0	6.0	11.0		
U1P00402	57	4/13/95 10:40	2100	3500													
U1P00501	18	4/13/95 13:20	2210	3600				6.3					6.3		6.3		
U1P00502	30	4/13/95 13:58	2210	3600							1.6			1.6	1.6		
U1P00601	18	4/13/95 14:35	2400	3600													
U1P00602	30	4/13/95 15:00	2400	3600							2.8			2.8	2.8		
U1P00603	45	4/13/95 15:25	2400	3600							3.3			3.3	3.3		
U1P00701	16	4/13/95 16:30	2600	3600													
U1P00702	30	4/13/95 16:50	2600	3600													
U1P00801	17	4/13/95 17:25	3000	3600							1.0			1.0	1.0		
U1P00901	15	4/14/95 8:00	3250	3250													
U1P00902	30	4/14/95 8:15	3250	3250													
U1P00902D	30	4/14/95 8:15	3250	3250													
U1P00903	22	5/22/95 13:15	3250	3250		1.5	1.5				0.9		3.0	0.9	3.9	DPT	CPT
U1P00904	54	5/22/95 14:40	3250	3250												DPT	
U1P01001	14	4/14/95 8:50	3250	3150													
U1P01002	33	4/14/95 9:07	3250	3150													
U1P01003	33	5/2/95 18:05	3250	3150	NOT ANALYZED ON FIELD GC, SENT DIRECTLY TO OFFSITE LAB												
U1P01101	18	4/14/95 9:38	2100	3600													
U1P01102	45	4/14/95 10:05	2100	3600													
U1P01201	18	4/14/95 10:40	2100	3400			1.2						1.2		1.2		

Notes:
(1) Concentrations are in micrograms/liter.
(2) Exceedances of Federal MCLs are shaded.
(3) FPDWS for m-,p-,o-xylenes is for total xylenes

TABLE B-1
FIELD GC RESULTS
TERRAPROBE/CONE PENETROMETER PROGRAM
OU 1, NORTH GRINDER LANDFILL

SAMPLE ID	DEPTH (BLS)	DATE/TIME	EASTING	NORTHING	BENZENE (FPDWS=1)	TOLUENE (FPDWS=1000)	ETHYLBENZENE (FPDWS=700)	M-,P-XYLENE (FPDWS=10,000)	O-XYLENE (FPDWS=10,000)	TCE (FPDWS=3)	PCE (FPDWS=3)	DCA (FPDWS=3)	ΣBETX	Σchlor	ΣVOCs	DPT SAMPLING LOCATIONS	CPT LOCATIONS
U1P01301	18	4/14/95 12:35	2100	3200													
U1P01401	15	4/14/95 13:35	2100	3000													
U1P01501	15	4/18/95 9:45	2700	3600													
U1P01501D	15	4/18/95 9:45	2700	3600							2.6			2.6	2.6		
U1P01502	39	4/18/95 10:10	2700	3600													
U1P01601	15	4/18/95 10:55	2500	3600													
U1P01602	39	4/18/95 11:15	2500	3600													
U1P01701	16	4/18/95 13:10	2300	3600													
U1P01702	39	4/18/95 13:35	2300	3600													
U1P01801	17	4/18/95 14:12	2700	2700													
U1P01901	10	4/18/95 15:15	2400	2740													
U1P01902	21	4/18/95 15:25	2400	2740	9.7	10.2	1.9	2.5	2.2				26.5		26.5		
U1P01903	10	5/2/95 17:00	2400	2740	NOT ANALYZED ON FIELD GC, SENT DIRECTLY TO OFFSITE LAB												CPT
U1P02001	6	4/18/95 16:00	2100	2700		3.0							3.0		3.0		
U1P02002	18	4/18/95 16:35	2100	2700													
U1P02002D	18	4/18/95 16:35	2100	2700													
U1P02101	6	4/18/95 16:55	2005	2900													
U1P02102	21	4/18/95 17:10	2005	2900		13.4		5.5					18.9		18.9		
U1P02103	24	5/10/95 11:44	2005	2900					1.2				1.2		1.2	DPT	CPT
U1P02104	49	5/10/95 12:55	2005	2900												DPT	
U1P02104D	49	5/10/95 12:55	2005	2900		0.0							0.0		0.0	DPT	
U1P02105	54	5/10/95 15:05	2005	2900			0.3	0.1	0.6		0.1		1.0	0.1	1.1	DPT	
U1P02201	12	4/19/95 8:14	2000	3100		2.4							2.4		2.4		
U1P02202	22	4/19/95 8:29	2000	3100		1.0							1.0		1.0		
U1P02301	14	4/19/95 9:05	2000	3300		6.3	2.3	4.0	3.5				16.1		16.1		CPT
U1P02301D	14	4/19/95 9:05	2000	3300		3.7	1.1	3.3	1.7				9.8		9.8		
U1P02302	20	4/19/95 9:18	2000	3300		11.2	4.2	4.6					20.0		20.0		
U1P02401	14	4/19/95 10:10	2000	3500													

Notes:
(1) Concentrations are in micrograms/liter.
(2) Exceedances of Federal MCLs are shaded.
(3) FPDWS for m-,p-,o-xylenes is for total xylenes

TABLE B-1
FIELD GC RESULTS
TERRAPROBE/CONE PENETROMETER PROGRAM
OU 1, NORTH GRINDER LANDFILL

SAMPLE ID	DEPTH (BLS)	DATE/TIME	EASTING	NORTHING	BENZENE (FPDWS=1)	TOLUENE (FPDWS=1000)	ETHYLBENZENE (FPDWS=700)	M-,P-XYLENE (FPDWS=10,000)	O-XYLENE (FPDWS=10,000)	TCE (FPDWS=3)	PCE (FPDWS=3)	DCA (FPDWS=3)	ΣBETX	Σchlor	ΣVOCs	DPT SAMPLING LOCATIONS	CPT LOCATIONS
U1P02402	40	4/19/95 10:27	2000	3500					13.3				13.3		13.3		
U1P02403	18	5/9/95 12:39	2000	3500		0.2			0.4		0.1		0.6	0.1	0.7	DPT	CPT
U1P02404	30	5/9/95 13:30	2000	3500												DPT	
U1P02405	53	5/9/95 15:30	2000	3500		0.4							0.4		0.4	DPT	
U1P02501	15	4/19/95 11:07	2000	3700		4.6	2.0	3.3	3.7				13.6		13.6		
U1P02502	34	4/19/95 11:28	2000	3700		7.9		4.9					12.8		12.8		
U1P02503	19	5/9/95 9:45	2000	3700												DPT	CPT
U1P02504	32	5/9/95 10:07	2000	3700												DPT	
U1P02505	52	5/9/95 10:45	2000	3700		0.3		0.1					0.4		0.4	DPT	
U1P02601	14	4/19/95 14:00	2000	3900													
U1P02701	16	4/19/95 14:30	2000	3800													
U1P02702	37	4/19/95 14:46	2000	3800		4.5							4.5		4.5		
U1P02702D	37	4/19/95 14:46	2000	3800		8.0							8.0		8.0		
U1P02801	19	4/19/95 15:34	2000	3600													
U1P02901	15	4/19/95 16:12	2000	3400		1.0		0.5					1.5		1.5		
U1P03001	11	4/19/95 16:45	2000	3200													
U1P03002	16	4/19/95 17:00	2000	3200		1.8	0.9	1.2	1.4				5.3		5.3		
U1P03101	14	4/20/95 8:27	2000	3000													
U1P03201	15	4/20/95 9:30	2300	3700				2.2					2.2		2.2		
U1P03202	36	4/20/95 9:45	2300	3700				4.6	6.1				10.7		10.7		
U1P03203	17	5/2/95 17:35	2300	3700	NOT ANALYZED ON FIELD GC, SENT DIRECTLY TO OFFSITE LAB												
U1P03301	15	4/20/95 10:28	2200	3700		3.0	2.6	4.3	3.6				13.5		13.5		
U1P03302	34	4/20/95 10:45	2200	3700			5.6	5.0	6.7				17.3		17.3		
U1P03302D	34	4/20/95 10:45	2200	3900													
U1P03303	19	5/10/95 17:19	2200	3700												DPT	CPT
U1P03304	50.5	5/11/95 7:39	2200	3700		0.3		0.2					0.5		0.5	DPT	
U1P03305	67	5/11/95 8:34	2200	3700												DPT	
U1P03401	16	4/20/95 11:31	2100	3700													

Notes:
(1) Concentrations are in micrograms/liter.
(2) Exceedances of Federal MCLs are shaded.
(3) FPDWS for m-,p-,o-xylenes is for total xylenes

TABLE B-1
FIELD GC RESULTS
TERRAPROBE/CONE PENETROMETER PROGRAM
OU 1, NORTH GRINDER LANDFILL

SAMPLE ID	DEPTH (BLS)	DATE/TIME	EASTING	NORTHING	BENZENE (FPDWS=1)	TOLUENE (FPDWS=1000)	ETHYLBENZENE (FPDWS=700)	M-,P-XYLENE (FPDWS=10,000)	O-XYLENE (FPDWS=10,000)	TCE (FPDWS=3)	PCE (FPDWS=3)	DCA (FPDWS=3)	ΣBETX	Σchlor	ΣVOCs	DPT SAMPLING LOCATIONS	CPT LOCATIONS
U1P03402	21	4/20/95 11:50	2100	3700		2.0							2.0		2.0		
U1P03501	17	4/20/95 13:50	2800	3700		2.5							2.5		2.5		
U1P03502	24	4/20/95 14:05	2800	3700		3.7							3.7		3.7		
U1P03601	16	4/20/95 14:44	2900	3700		1.6		0.8					2.4		2.4		
U1P03602	31	4/20/95 14:58	2900	3700	0.4								0.4		0.4		
U1P03602D	31	4/20/95 14:58	2900	3700													
U1P03603	27	34831.42847	2900	3700												DPT	CPT
U1P03604	52	5/12/95 12:39	2900	3700												DPT	
U1P03701	16	4/20/95 15:40	3000	3700													
U1P03702	31	4/20/95 16:00	3000	3700	1.2								1.2		1.2		
U1P03801	15	4/20/95 16:20	3100	3700													
U1P03802	28	4/20/95 16:50	3100	3700													
U1P03901	17	4/21/95 8:15	2690	3720	3.7								3.7		3.7		
U1P03902	30	4/21/95 8:29	2690	3720													
U1P03903	38	5/12/95 7:59	2690	3720	0.1	0.0							0.2		0.2	DPT	CPT
U1P03904	56.5	5/12/95 9:25	2690	3720												DPT	
U1P04001	16	4/21/95 9:20	3250	3720													
U1P04002	25	4/21/95 9:36	3250	3720													
U1P04101	15	4/21/95 10:17	3000	3800													
U1P04101D	15	4/21/95 10:17	3000	3800			1.0						1.0		1.0		
U1P04102	37	4/21/95 10:31	3000	3800													
U1P04201	17	4/21/95 11:20	2800	3800													
U1P04202	34	4/21/95 11:37	2800	3800													
U1P04301	17	4/21/95 13:36	2600	3800													
U1P04302	31	4/21/95 13:50	2600	3800													
U1P04401	16	4/24/95 9:51	2400	3800													
U1P04402	22	4/24/95 10:08	2400	3800													
U1P04402D	28	4/24/95 10:08	2400	3800													

Notes:
(1) Concentrations are in micrograms/liter.
(2) Exceedances of Federal MCLs are shaded.
(3) FPDWS for m-,p-,o-xylenes is for total xylenes

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FIELD GC RESULTS
TERRAPROBE/CONE PENETROMETER PROGRAM
OU 1, NORTH GRINDER LANDFILL

SAMPLE ID	DEPTH (BLS)	DATE/TIME	EASTING	NORTHING	BENZENE (FPDWS=1)	TOLUENE (FPDWS=1000)	ETHYLBENZENE (FPDWS=700)	M-,P-XYLENE (FPDWS=10,000)	O-XYLENE (FPDWS=10,000)	TCE (FPDWS=3)	PCE (FPDWS=3)	DCA (FPDWS=3)	ΣBETX	Σchlor	ΣVOCs	DPT SAMPLING LOCATIONS	CPT LOCATIONS
U1P04501	17	4/24/95 10:45	2200	3800		0.8							0.8		0.8		
U1P04502	36	4/24/95 11:03	2200	3800													
U1P04601	19	4/24/95 12:06	2300	3800													
U1P04602	33	4/24/95 12:30	2300	3800													
U1P04701	16	4/24/95 14:43	2500	3800													
U1P04702	33	4/24/95 15:00	2500	3800													
U1P04801	18	4/24/95 15:45	3250	3600													
U1P04802	33	4/24/95 16:04	3250	3600													
U1P04802D	33	4/24/95 16:04	3250	3600													
U1P04803	43	5/9/95 17:02	3250	3600				0.0			0.5		0.0	0.5	0.5	DPT	CPT
U1P04803D	43	5/9/95 17:02	3250	3600												DPT	
U1P04804	47	5/10/95 8:07	3250	3600												DPT	
U1P04805	70	5/10/95 10:04	3250	3600					0.1				0.1		0.1	DPT	
U1P04901	16	4/24/95 16:45	3250	3500													
U1P04902	30	4/24/95 17:04	3250	3500													
U1P05001	15	4/24/95 8:12	3200	2800													
U1P05002	33	4/24/95 8:40	3200	2800	7.5								7.5		7.5		
U1P05003	22.5	5/22/95 9:25	3200	2800												DPT	CPT
U1P05004	67	5/22/95 11:20	3200	2800		2.1				0.7			2.1	0.7	2.8	DPT	
U1P05101	15	4/25/95 9:16	3250	3000													
U1P05102	27	4/25/95 9:45	3250	3000													
U1P05201	17	4/25/95 11:11	2200	4100													
U1P05202	33	4/25/95 11:11	2200	4100													
U1P05203	23	5/11/95 9:40	2200	4100							0.0			0.0	0.0	DPT	CPT
U1P05204	32.5	5/11/95 10:27	2200	4100												DPT	
U1P05205	56	5/11/95 12:00	2200	4100		0.1							0.1		0.1	DPT	
U1P05205D	56	5/11/95 12:00	2200	4100												DPT	
U1P05301	22	4/25/95 14:05	2500	4100		2.0							2.0		2.0		

Notes:
(1) Concentrations are in micrograms/liter.
(2) Exceedances of Federal MCLs are shaded.
(3) FPDWS for m-,p-,o-xylenes is for total xylenes

TABLE B-1
FIELD GC RESULTS
TERRAPROBE/CONE PENETROMETER PROGRAM
OU 1, NORTH GRINDER LANDFILL

SAMPLE ID	DEPTH (BLS)	DATE/TIME	EASTING	NORTHING	BENZENE (FPDWS=1)	TOLUENE (FPDWS=1000)	ETHYLBENZENE (FPDWS=700)	M-,P-XYLENE (FPDWS=10,000)	O-XYLENE (FPDWS=10,000)	TCE (FPDWS=3)	PCE (FPDWS=3)	DCA (FPDWS=3)	ΣBETX	Σchlor	ΣVOCs	DPT SAMPLING LOCATIONS	CPT LOCATIONS
U1P05301D	22	4/25/95 14:05	2500	4100													
U1P05302	33	4/26/95 14:27	2500	4100													
U1P05401	16	4/26/95 15:23	2900	4100													
U1P05501	15	4/26/95 16:22	3200	4100													CPT
U1P05502	30	4/26/95 16:40	3200	4100													
U1P056	14	5/5/95 7:55	2700	3250	(NO SAMPLE RECOVERED)												CPT
U1P05701	28	5/22/95 16:20	2720	4080		1.4							1.4		1.4	DPT	CPT
U1P05702	51.5	5/23/95 9:24	2720	4080	2.7			1.1			0.7		3.8	0.7	4.5	DPT	
U1P05801	19	5/23/95 11:30	3300	4080				0.1					0.1		0.1	DPT	CPT
U1P05802	42	5/23/95 12:45	3300	4080		1.9	1.3	0.6			0.8		3.8	0.8	4.6	DPT	
U1P05901	23	5/17/95 8:55	2570	3250												DPT	CPT
U1P05902	57	5/17/95 10:05	2570	3250												DPT	
MAXIMUM DETECTED CONCENTRATION					9.7	13.4	5.6	6.3	13.3	0.7	7.3		26.5	7.3	26.5		

Notes:
(1) Concentrations are in micrograms/liter.
(2) Exceedances of Federal MCLs are shaded.
(3) FPDWS for m-,p-,o-xylenes is for total xylenes

Table B-2. Summary of Groundwater Analytical Results
DPT Groundwater Samples

Remedial Investigation/Feasibility Study
Operable Unit 1, North Grinder Landfill
Naval Training Center, Orlando
Orlando, FL

Sample ID	U1P01003		U1P01903		U1P03203		U1P03603		U1P03604		U1P03903		U1P03904		U1P05205D				U1P05901		U1P05902	
Lab ID	G7466001		G7466002		G7466003		G7551004		G7564001		G7551002		G7551003		G755100		G7551001DL		G7610002		G7610001	
Sampling Date	5/2/95		5/2/95		5/2/95		5/12/95		5/12/95		5/12/95		5/12/95		5/11/95		5/11/95		5/17/95		5/17/95	
Volatile Organics, ug/L																						
1,1,1-Trichloroethane	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
1,1,2,2-Tetrachloroethane	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
1,1,2-Trichloroethane	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
1,1-Dichloroethane	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
1,1-Dichloroethene	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
1,2-Dichloroethane	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
1,2-Dichloroethene (total)	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
1,2-Dichloropropane	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
2-Butanone	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
2-Hexanone	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
4-Methyl-2-pentanone	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Acetone	14		10	U	10	U	10	U	9	J	70		10	U	240	ER	280	D	8	J	14	
Benzene	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Bromodichloromethane	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Bromoform	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Bromomethane	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Carbon disulfide	5	U	5	U	5	U	120		44		8	J	90		64		49	DR	2	J	4	J
Carbon tetrachloride	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Chlorobenzene	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	2	J
Chloroethane	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Chloroform	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Chloromethane	6	J	10	U	10	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
cis-1,3-Dichloropropene	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Dibromochloromethane	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Ethylbenzene	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Methylene chloride	5	U	5	U	2	J	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Styrene	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Tetrachloroethene	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Toluene	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
trans-1,3-Dichloropropene	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Trichloroethene	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Vinyl chloride	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Xylene (total)	5	U	5	U	5	U	10	U	10	U	10	U	10	U	10	U	20	UR	10	U	10	U
Tentatively Identified Compounds, ug/L																						
1-Pentene	33	U	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Propene	130	NJ	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	

APPENDIX C

CONE PENETROMETER TESTING RESULTS

FUGRO

FUGRO GEOSCIENCES, INC.

6105 Rookin
Houston, Texas 77074
Tel: (713) 778-5580
Fax: (713) 778-5501

July 24, 1995
Report Number 0301-5052-1

ABB Environmental Services, Inc.
1536 Kinglsey Avenue, Suite 127
Orange Park, Florida 32073

Attention: Mr. Rick Allan

FINAL REPORT
CONE PENETROMETER TESTING
AND DPT SAMPLING SERVICES
NTC ORLANDO, FLORIDA
PRIME CONTRACT NO.: N62467-89-D-0317

Dear Mr. Allan:

Please find enclosed herewith the final results of the cone penetrometer tests conducted at the above referenced location.

For your information, the soil stratigraphy was identified using Campanella and Robertson's Simplified Soil Behavior Chart. Please note that because of the empirical nature of the soil behavior chart, the soil identification should be verified locally.

Fugro Geosciences appreciates the opportunity to be of service to your organization. If you should have any questions, or if we can be of further assistance, please do not hesitate to contact us. We look forward to working with you in the future.

Very truly yours,
FUGRO GEOSCIENCES, INC.

Recep Yilmaz
Recep Yilmaz
President

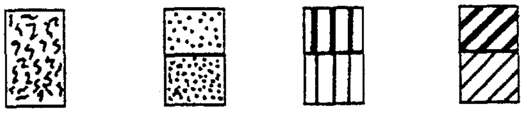
RY/ty

Enclosure: Diskettes

Key To Soil Classification and Symbols

SOIL TYPE
(Shown in Symbol Column)

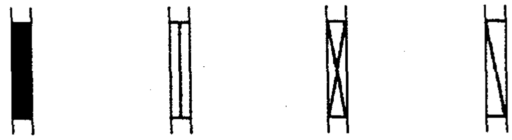
Sand Silt Clay



Fill Sandy Silty Clayey

Predominant Type Shown Heavy

SAMPLE TYPE
(Shown in Samples Column)



Undisturbed Rock Core Split Spoon No Recovery

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (Major portion Retained on No. 200 Sieve)
Includes (1) clean gravels and sand described as fine, medium or course, depending on distribution of grain sizes (2) silty or clayey gravels and sands and (3) fine grained low plasticity soils (PI < 10) such as sandy silts. Condition is rated according to relative density, as determined by lab tests or estimated from resistance to sampler penetration.

Descriptive Term	Penetration Resistance*	Relative Density
Loose	0 - 10	0 to 40%
Medium Dense	10 - 30	40 to 70%
Dense	30 - 50	70 to 90%
Very Dense	Over 50	90 to 100%

* Blows/Foot, 140# Hammer, 30" Drop

FINE GRAINED SOILS (Major Portion Passing No. 200 Sieve)
Includes (1) inorganic and organic silts and clays, (2) sandy, gravelly or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests for soils with PI $\geq$ 10.

Descriptive Term	Cohesive Shear Strength Tons/Square Foot
Very Soft	Less Than 0.125
Soft	0.125 to 0.25
Firm	0.25 to 0.50
Stiff	0.50 to 1.00
Very Stiff	1.00 to 2.00
Hard	2.00 and Higher

Note: Slickensided and fissured clay may have lower unconfined compressive strengths than shown above because of planes of weakness or shrinkage cracks; consistency ratings of such soils are based on hand penetrometer readings.

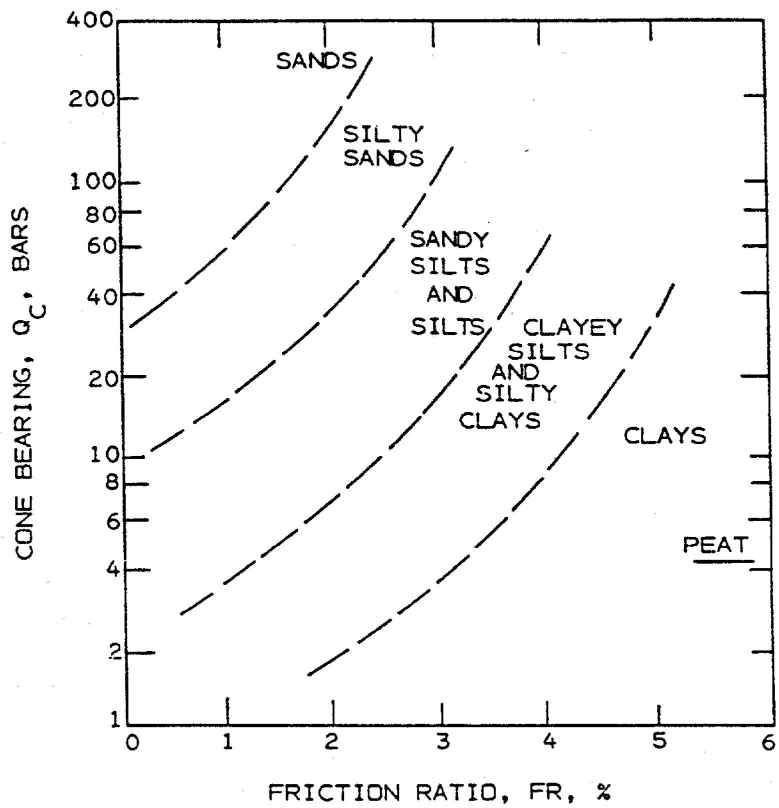
TERMS CHARACTERIZING SOIL STRUCTURE

Parting: paper thin in size
Seam: 1/8" to 3" thick
Layer: greater than 3"
Fissured: containing shrinkage cracks, frequently filled with fine sand or silt, usually more or less vertical
Sensitive: pertaining to cohesive soils that are subject to appreciable loss of strength when remolded
Interbedded: composed of alternate layers of different soil types
Laminated: composed of thin layers of varying color and texture
Calcareous: containing appreciable quantities of calcium carbonate
Well Graded: having wide range in grain sizes and substantial amounts of all intermediate particle sizes
Poorly Graded: predominantly of one grain size, or having a range of sizes with some intermediate size missing
Flocculated: pertaining to cohesive soils that exhibit a loose knit or flakey structure
Slickensided: having inclined planes of weakness that are slick and glossy in appearance.

Degree of Slickensided Development

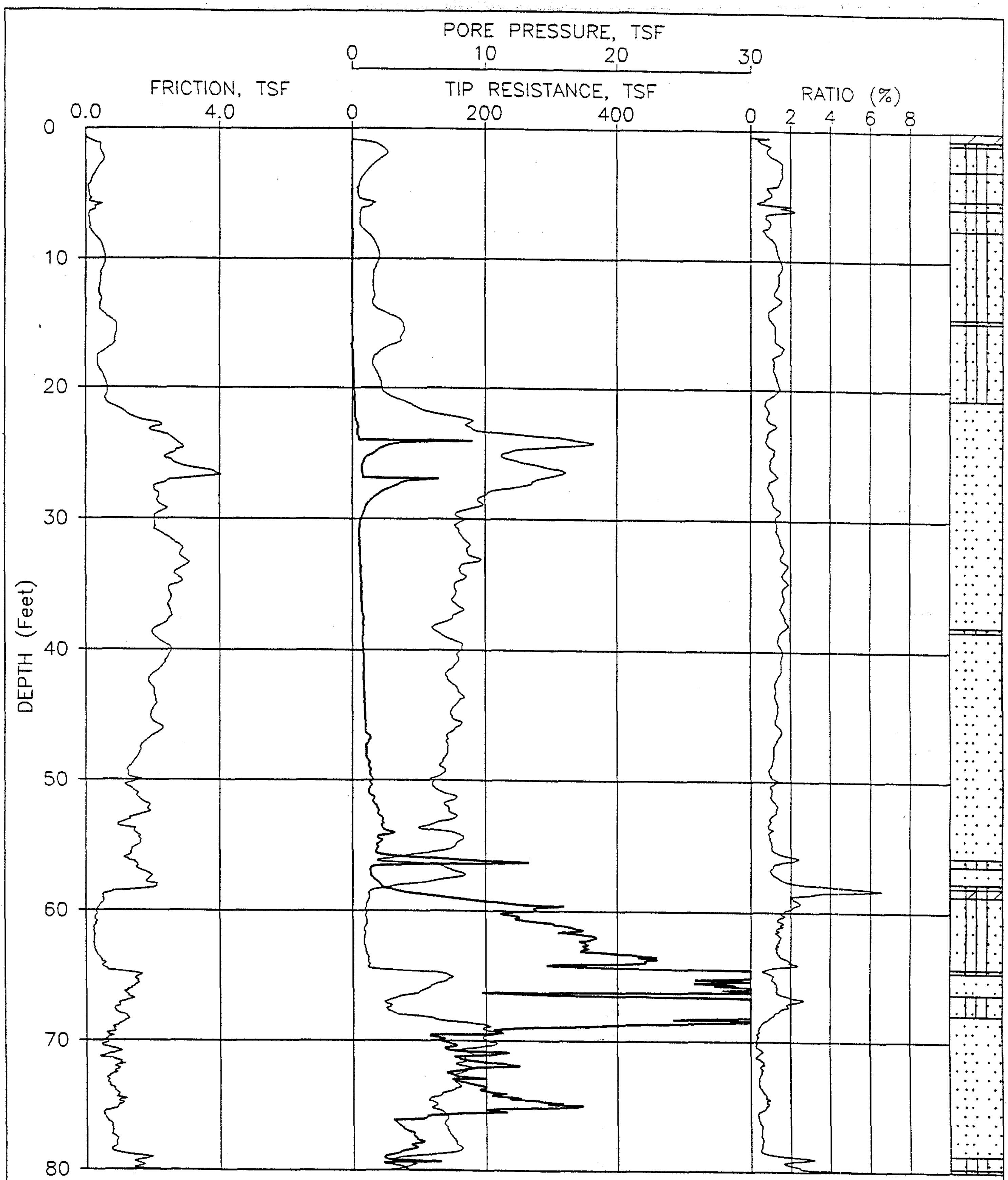
Slightly Slickensided: slickensides present at intervals of 1' to 2', soil does not easily break along these plates
Moderately Slickensided: slickensides spaced at intervals of 1' to 2', soil breaks easily along these planes
Extremely Slickensided: continuous and interconnected slickensides spaced at intervals of 4" to 12', soil breaks along the slickensides into pieces 3" to 6" in size
Intensely Slickensided: slickensides spaced at intervals of less than 4", continuous in all directions; soil breaks down along planes into nodules 1/4" to 2" in size.

1 BAR = 100KPA = 1.02 KG/CM^2



CAMPANELLA AND ROBERTSON CLASSIFICATION CHART

CONE PENETROMETER TESTS



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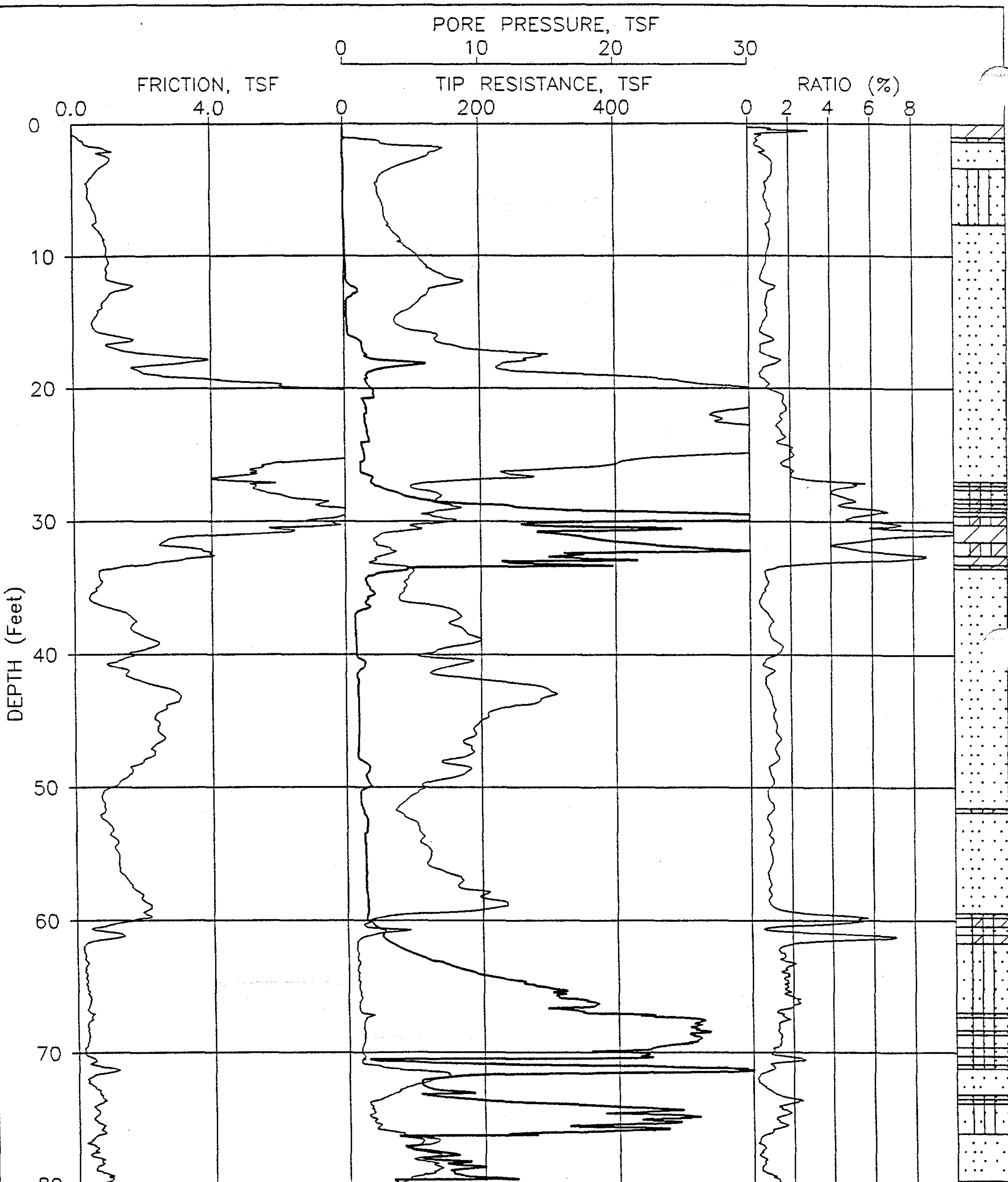
CONE NUMBER:F7.5CKEW169
DATE : 05-12-1995

FUGRO GEOSCIENCES,INC



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DATE : 05-04-1995

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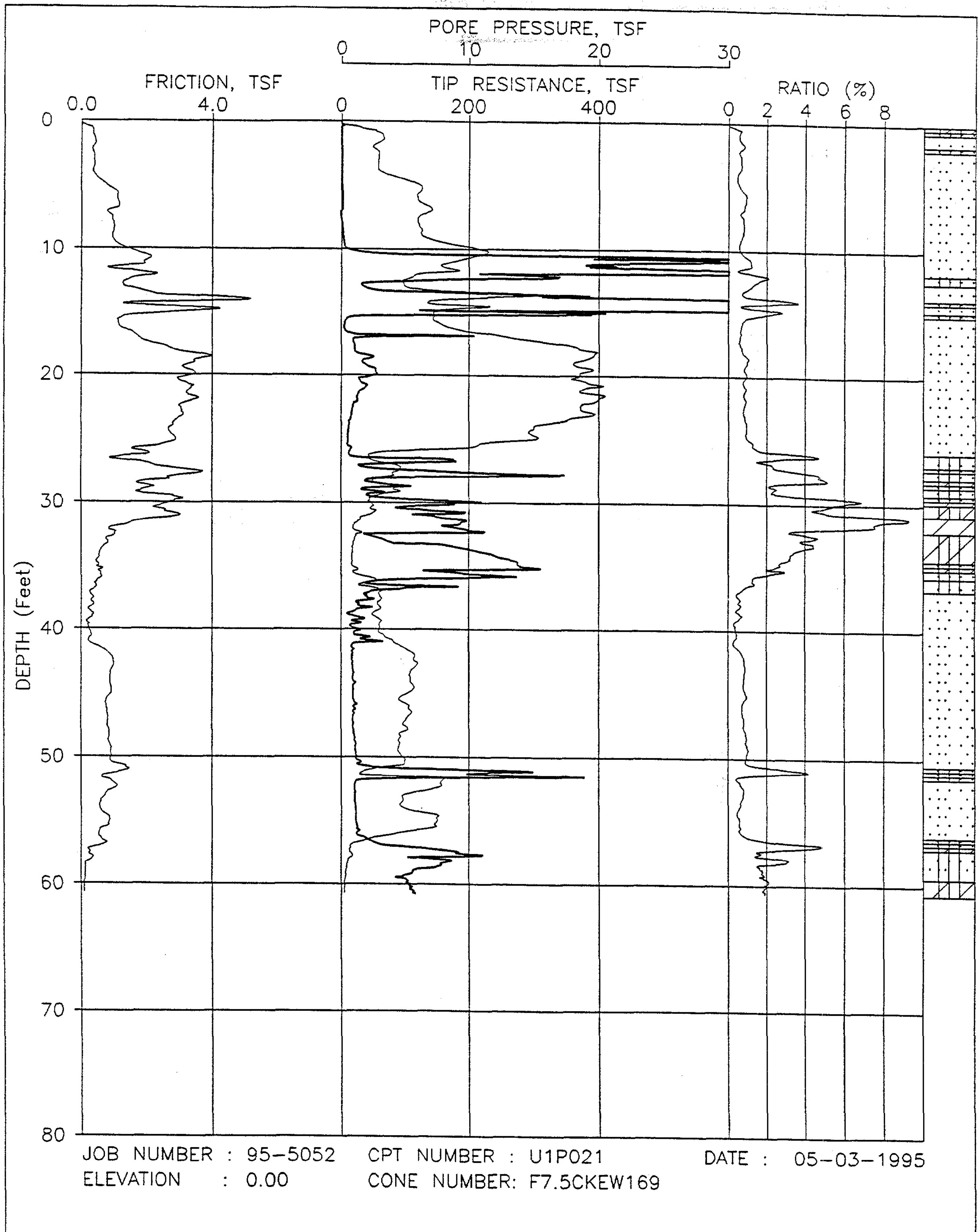

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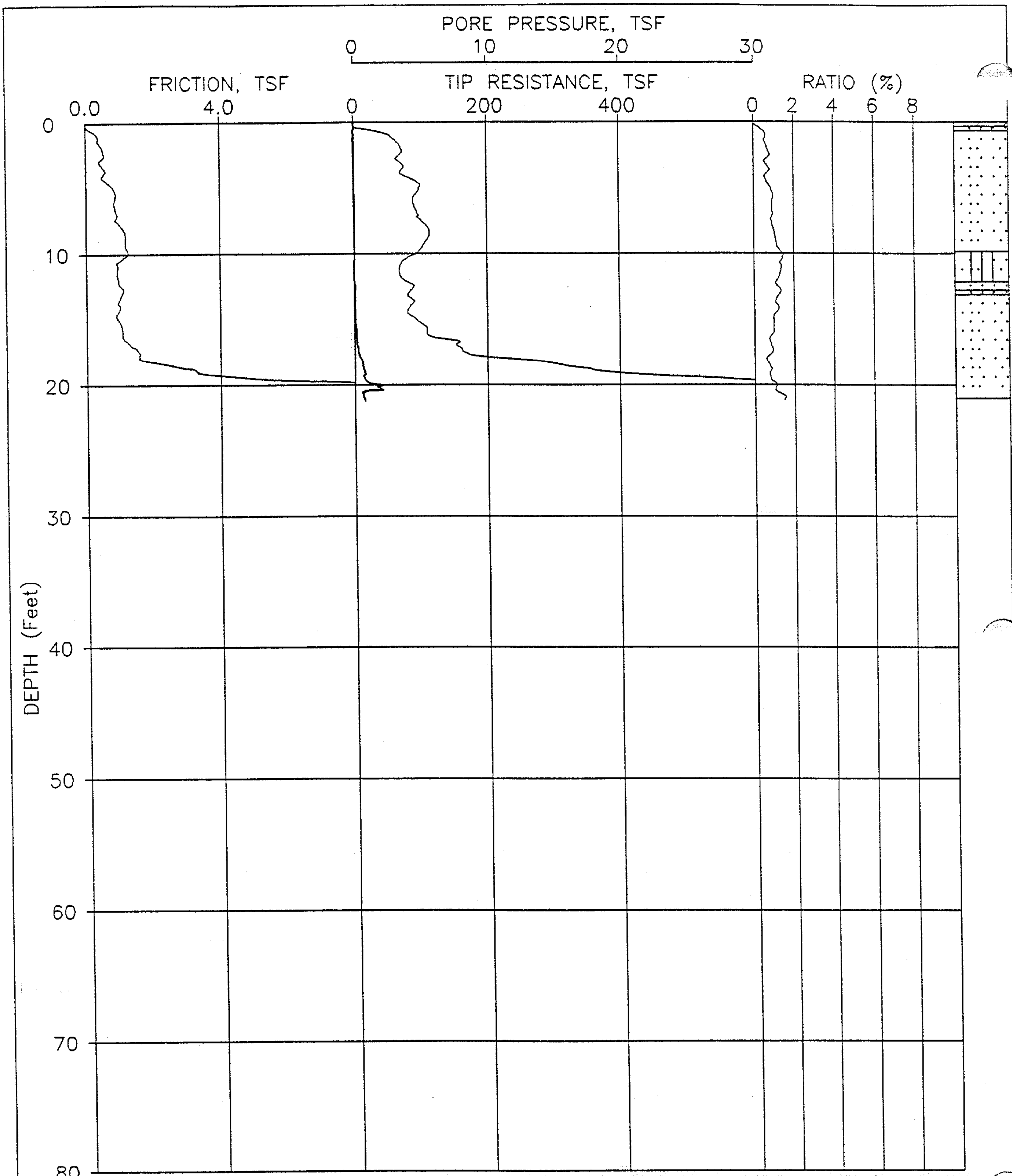

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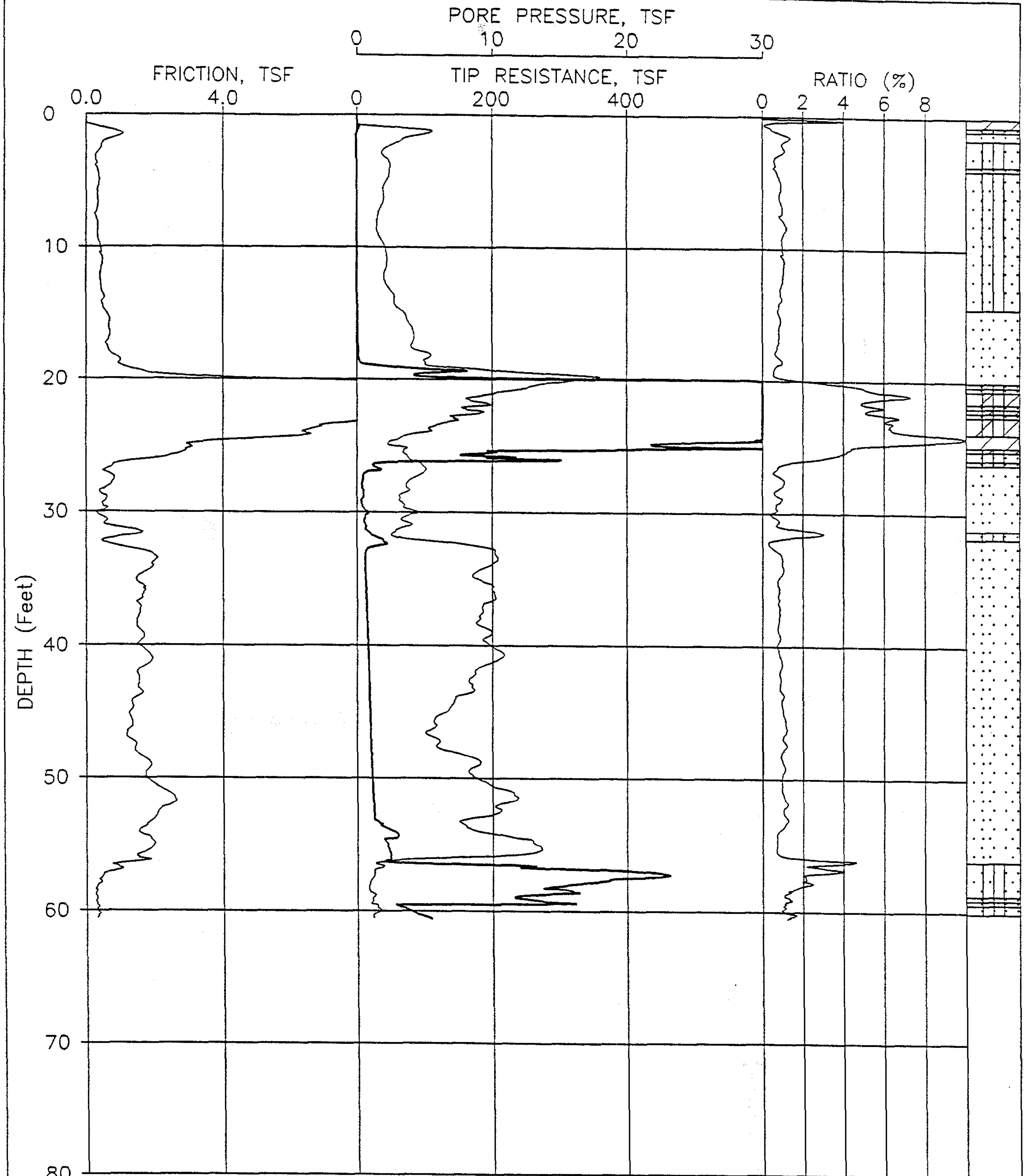
ELEVATION : 0.00 CONE NUMBER: F7.5CKEW169

FUGRO GEOSCIENCES,INC



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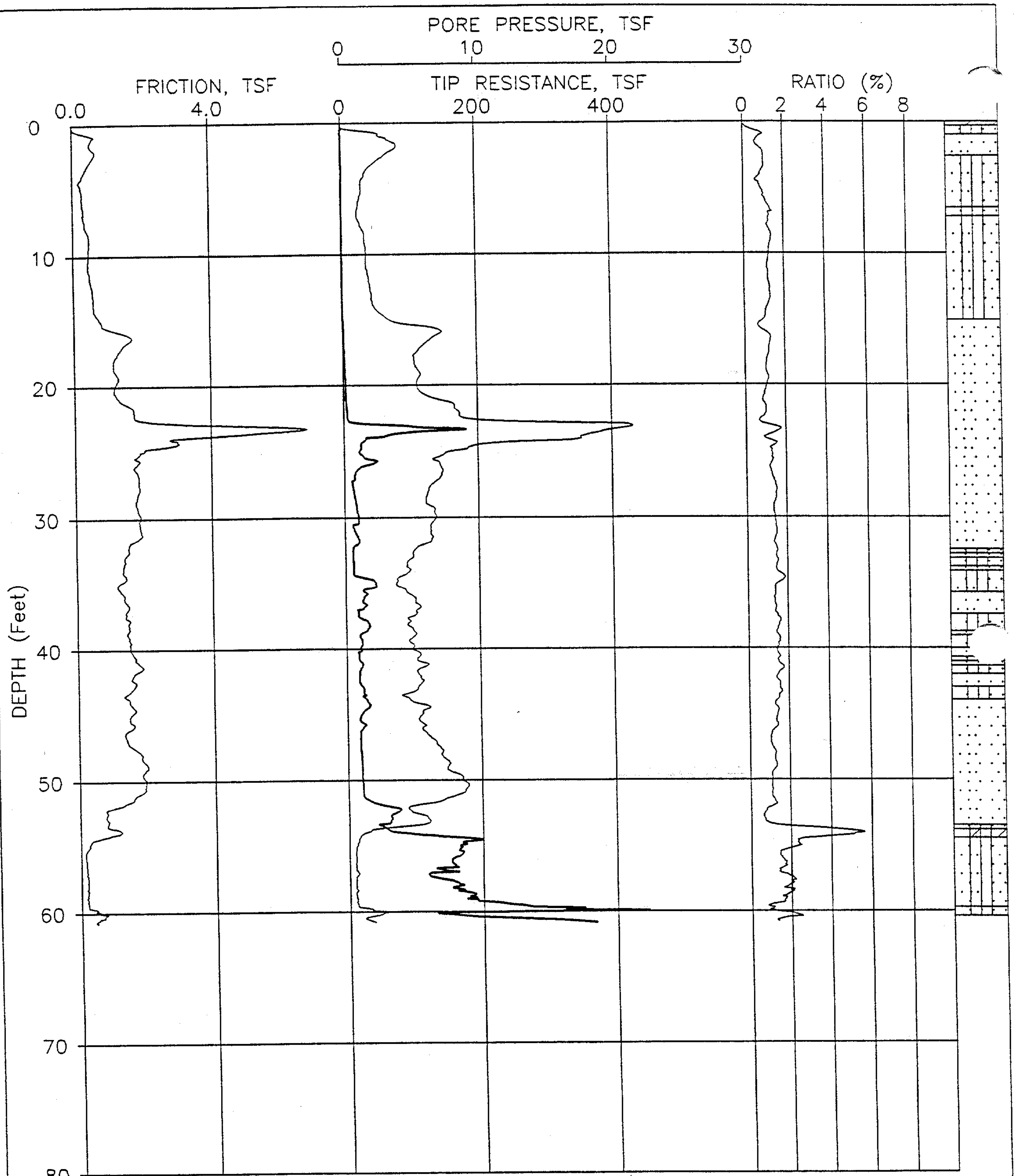
CONE NUMBER:F7.5CKEW169
DATE : 05-03-1995

FUGRO GEOSCIENCES,INC



JOB NUMBER :95-5052
ELEVATION : 0.00

CPT NUMBER :U1P025
CONE NUMBER:F7.5CKEW169

DATE : 05-04-1995

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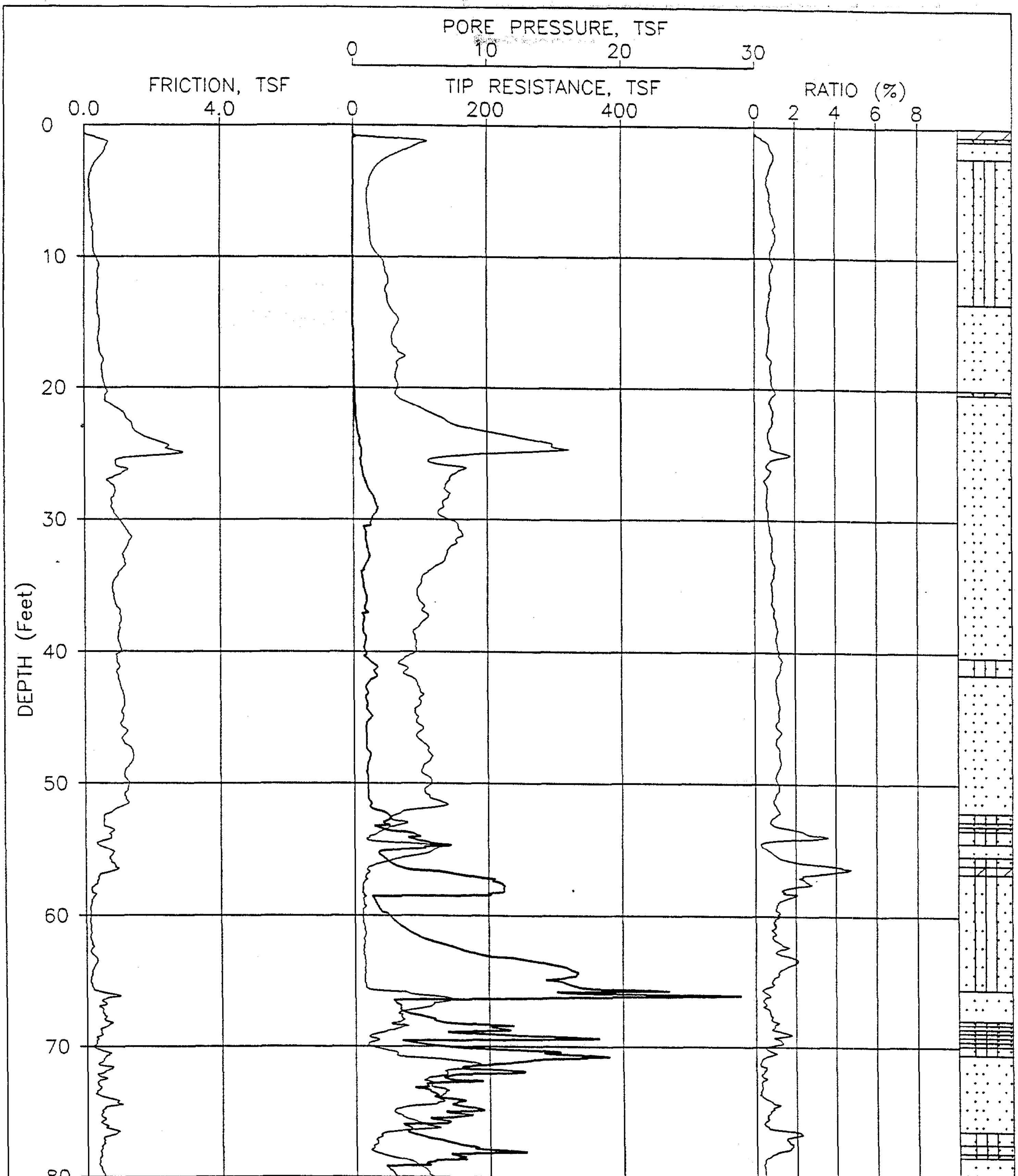

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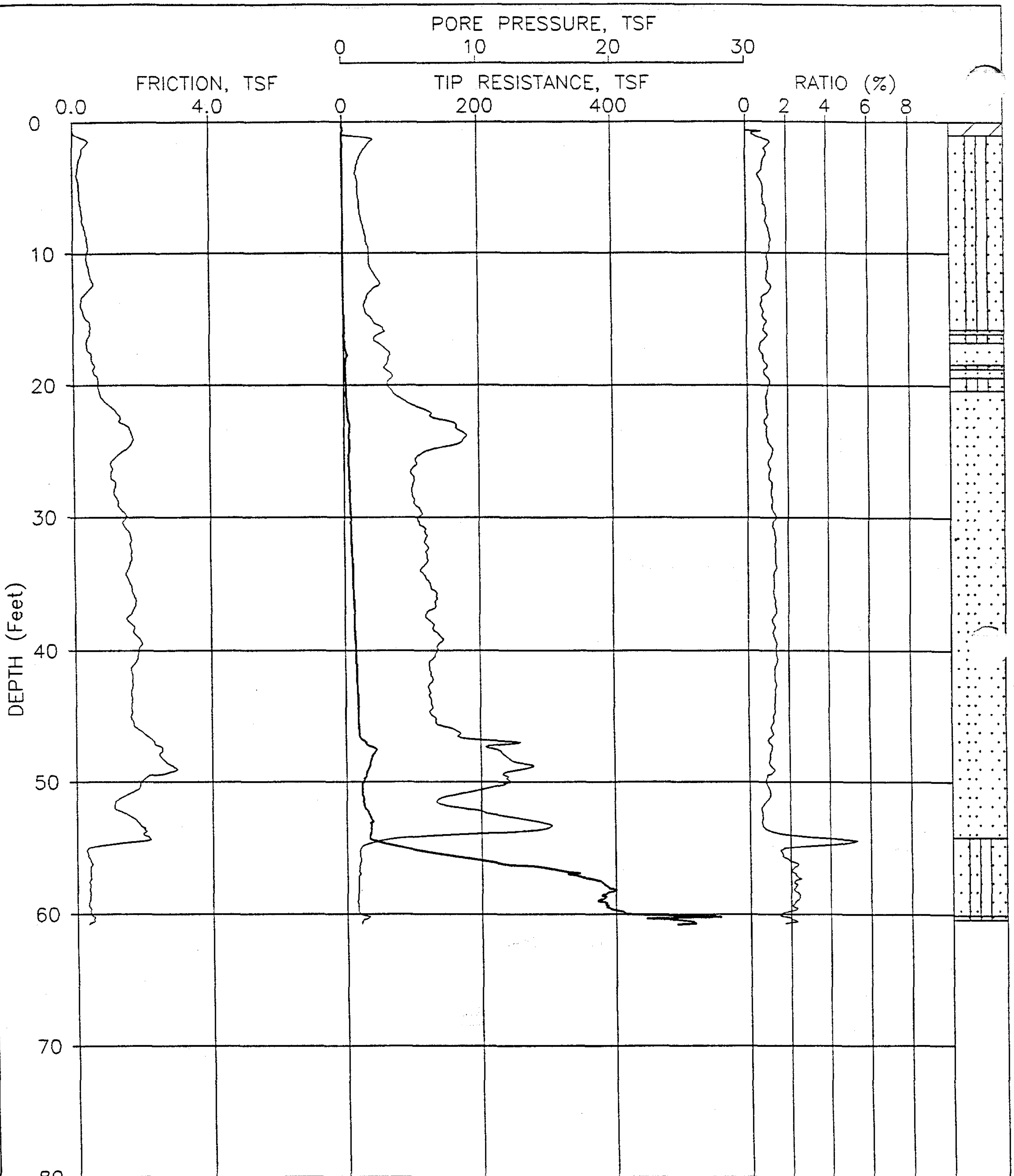
ELEVATION : 0.00

CPT NUMBER :U1P033
CONE NUMBER:F7.5CKEW169

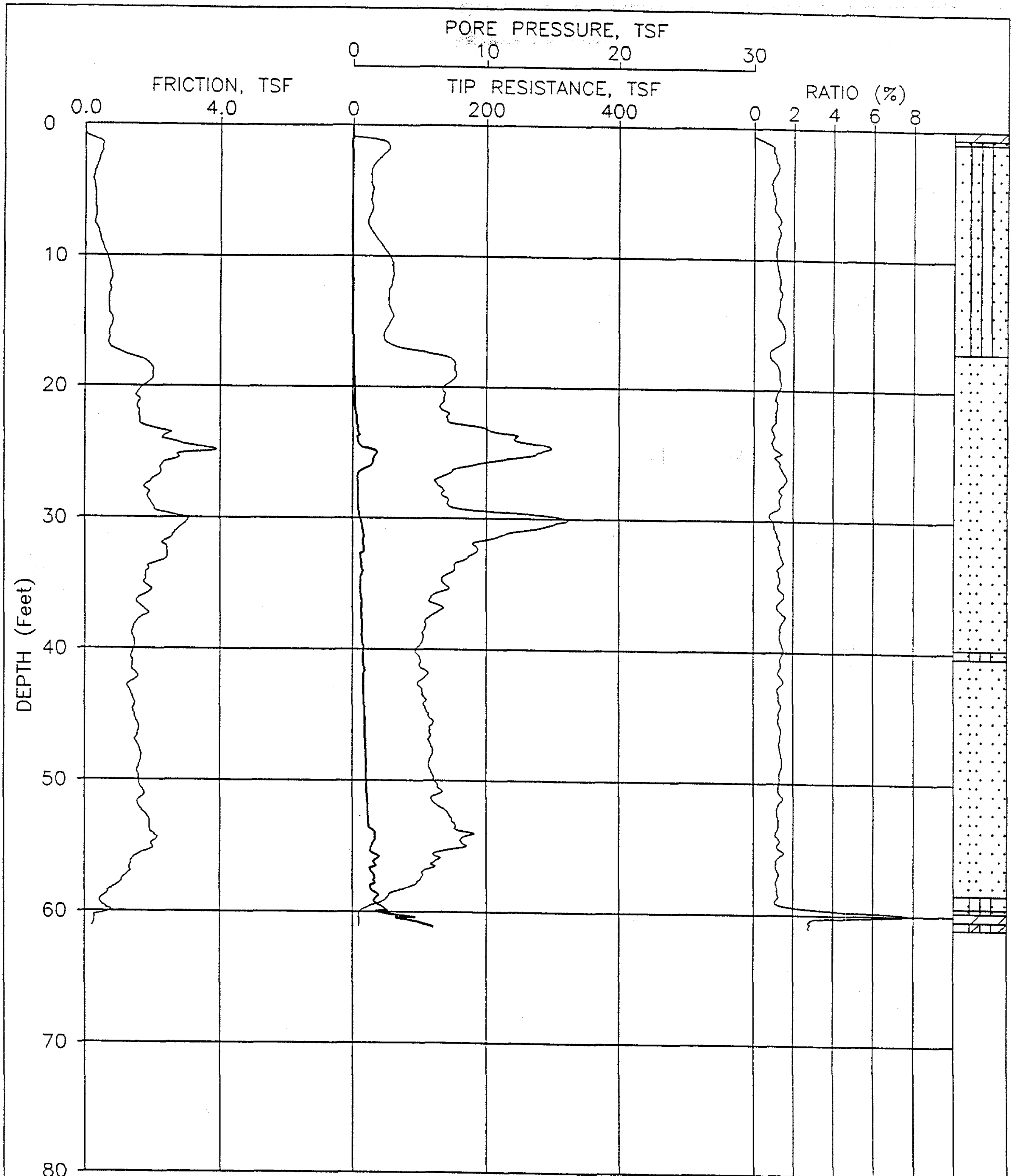
DATE : 05-03-1995

FUGRO GEOSCIENCES,INC



JOB NUMBER :95-5052 CPT NUMBER :U1P036 DATE : 05-04-1995
ELEVATION : 0.00 CONE NUMBER:F7.5CKEW169

FUGRO GEOSCIENCES,INC



JOB NUMBER :95-5052
ELEVATION : 0.00

CPT NUMBER :U1P039
CONE NUMBER:F7.5CKEW169

DATE : 05-04-1995

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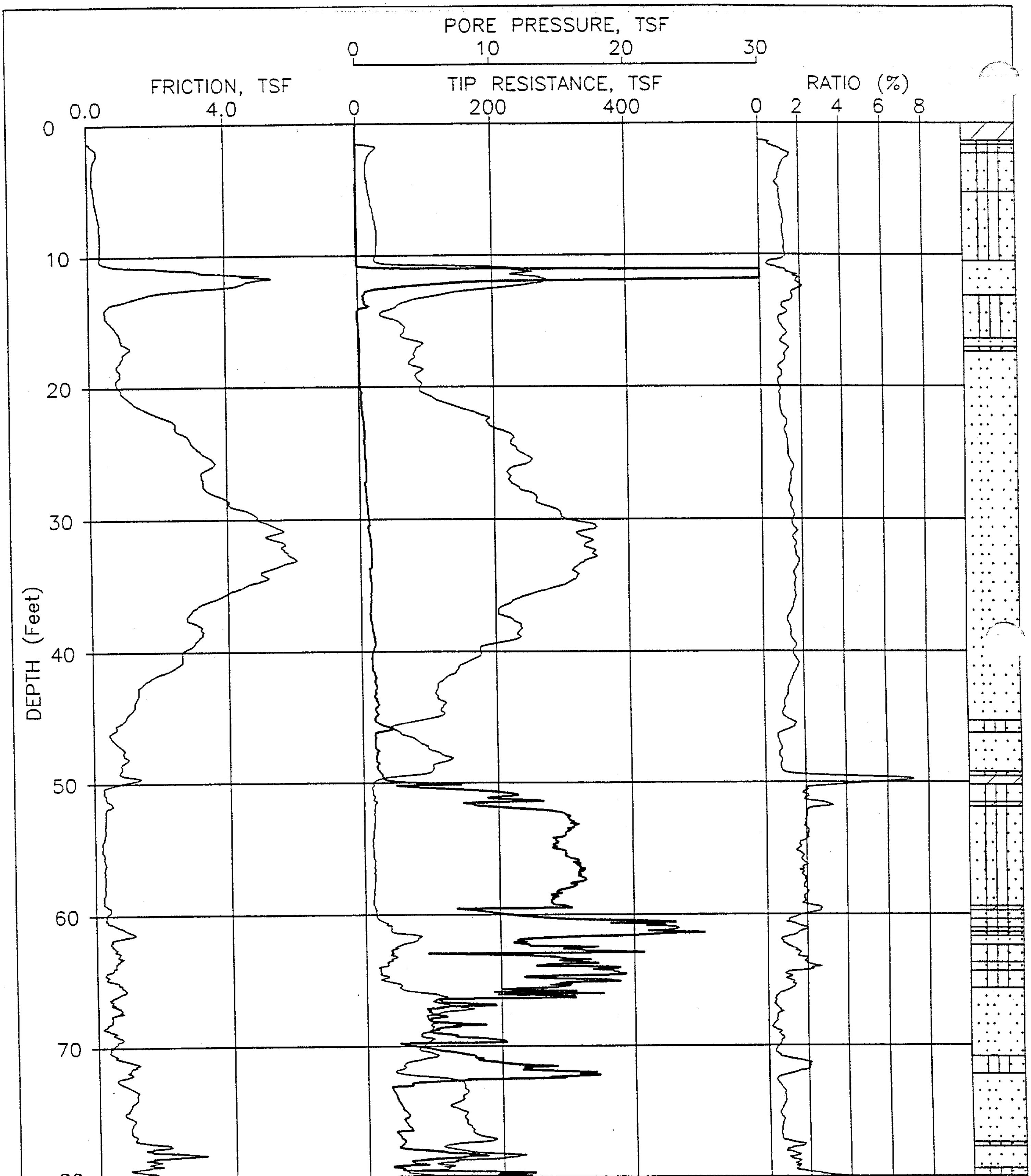

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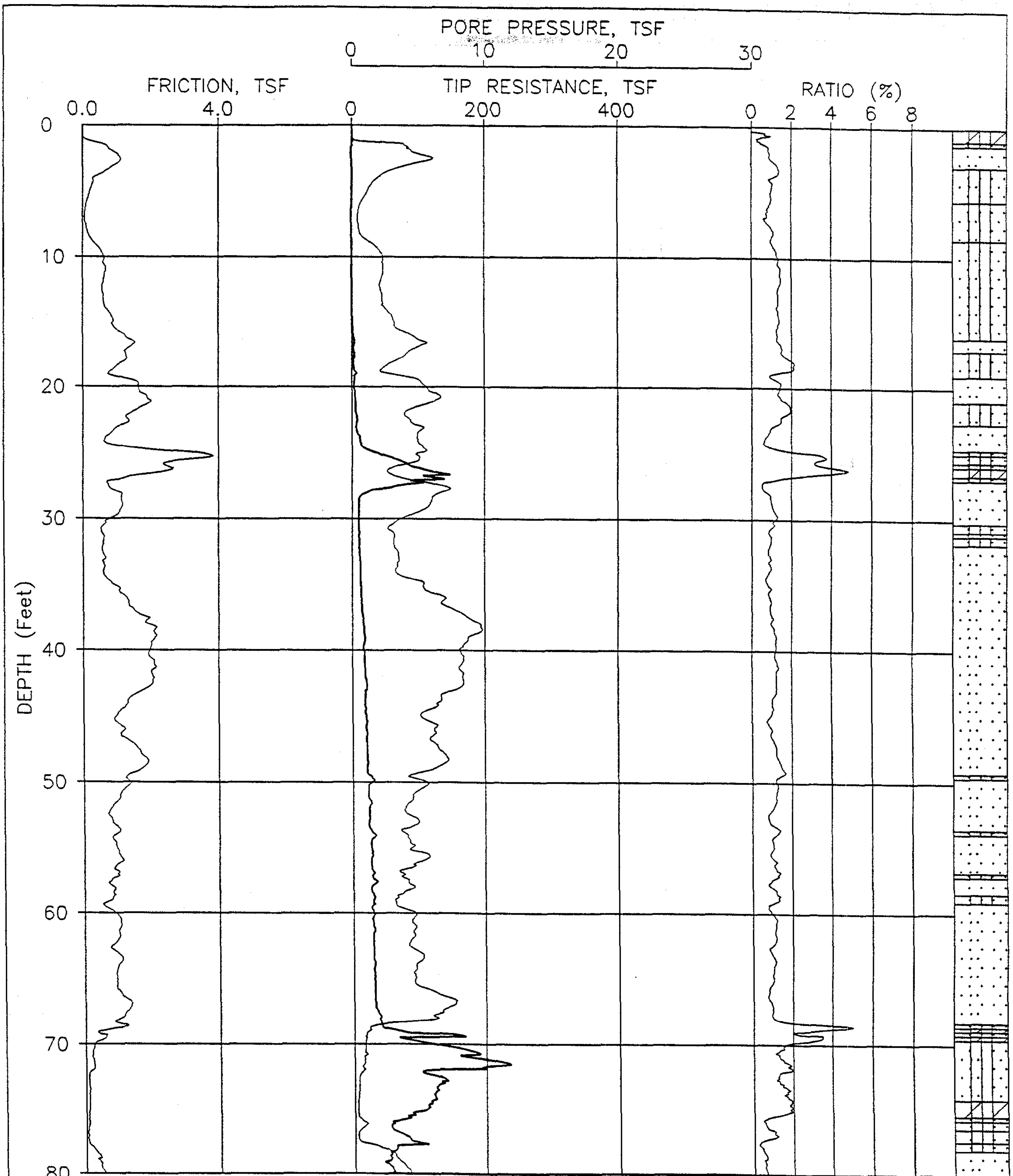
ELEVATION : 0.00

CPT NUMBER :U1P048
CONE NUMBER:F7.5CKEW169

DATE : 05-04-1995

FUGRO GEOSCIENCES,INC

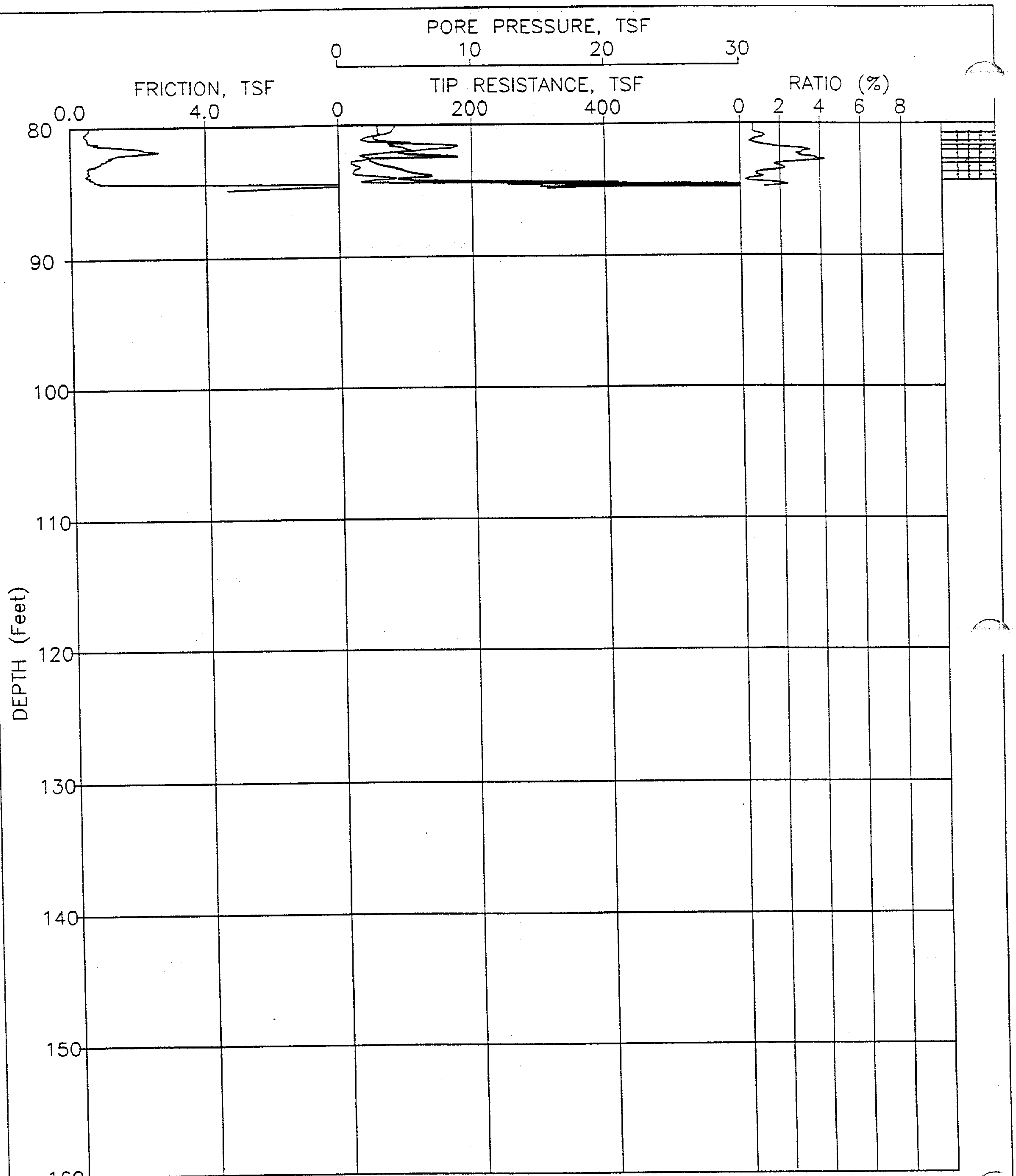


JOB NUMBER: 95-5052
ELEVATION: 0.00

CPT NUMBER: U1P050
CONE NUMBER:F7.5CKEW169

DATE: 05-05-1995
PLATE: 1 OF 2

FUGRO GEOSCIENCES,INC



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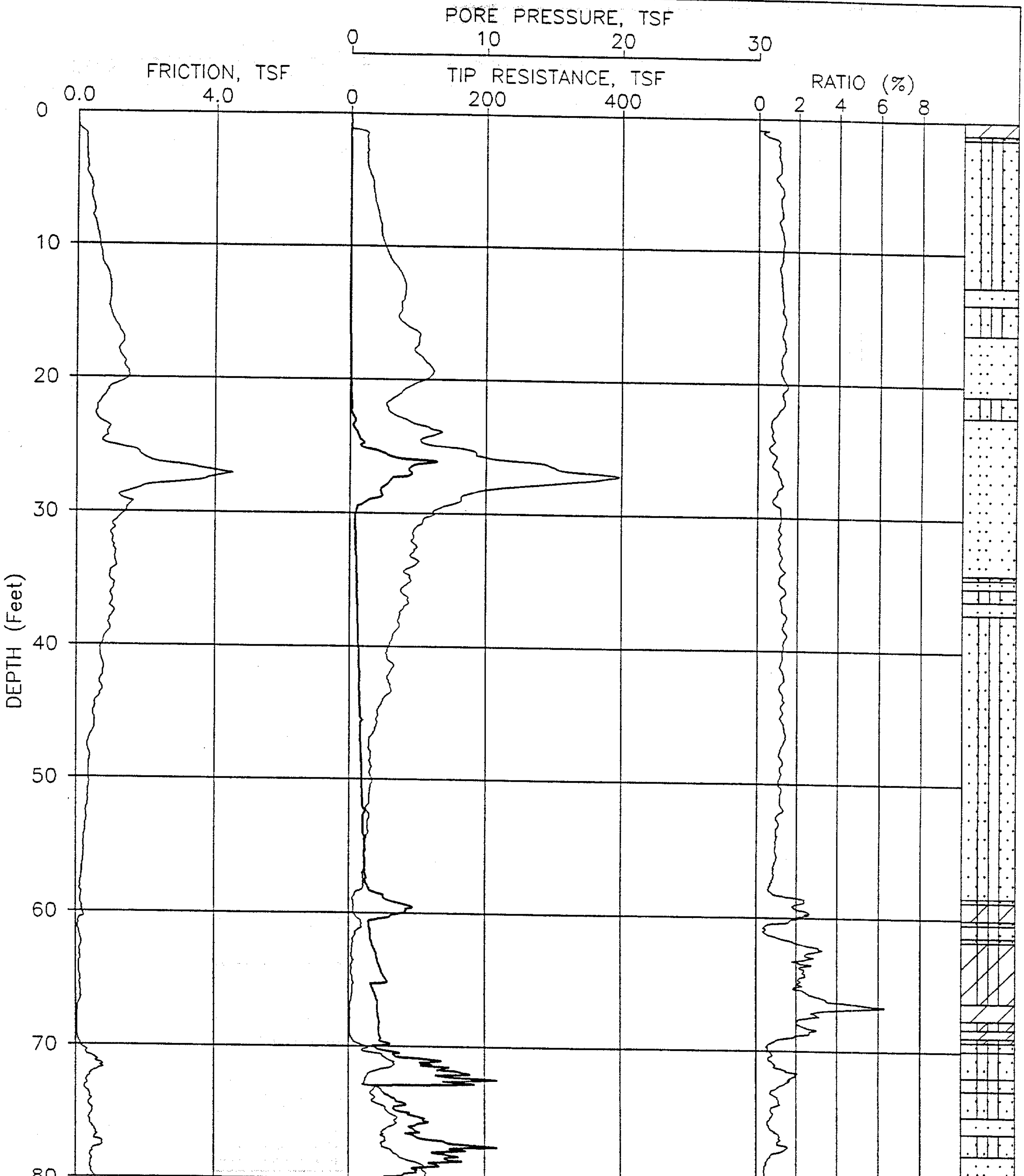
CONE NUMBER:F7.5CKEW169

DATE: 05-05-1995
PLATE: 2 OF 2

FUGRO GEOSCIENCES,INC



JOB NUMBER: 95-5052
ELEVATION: 0.00

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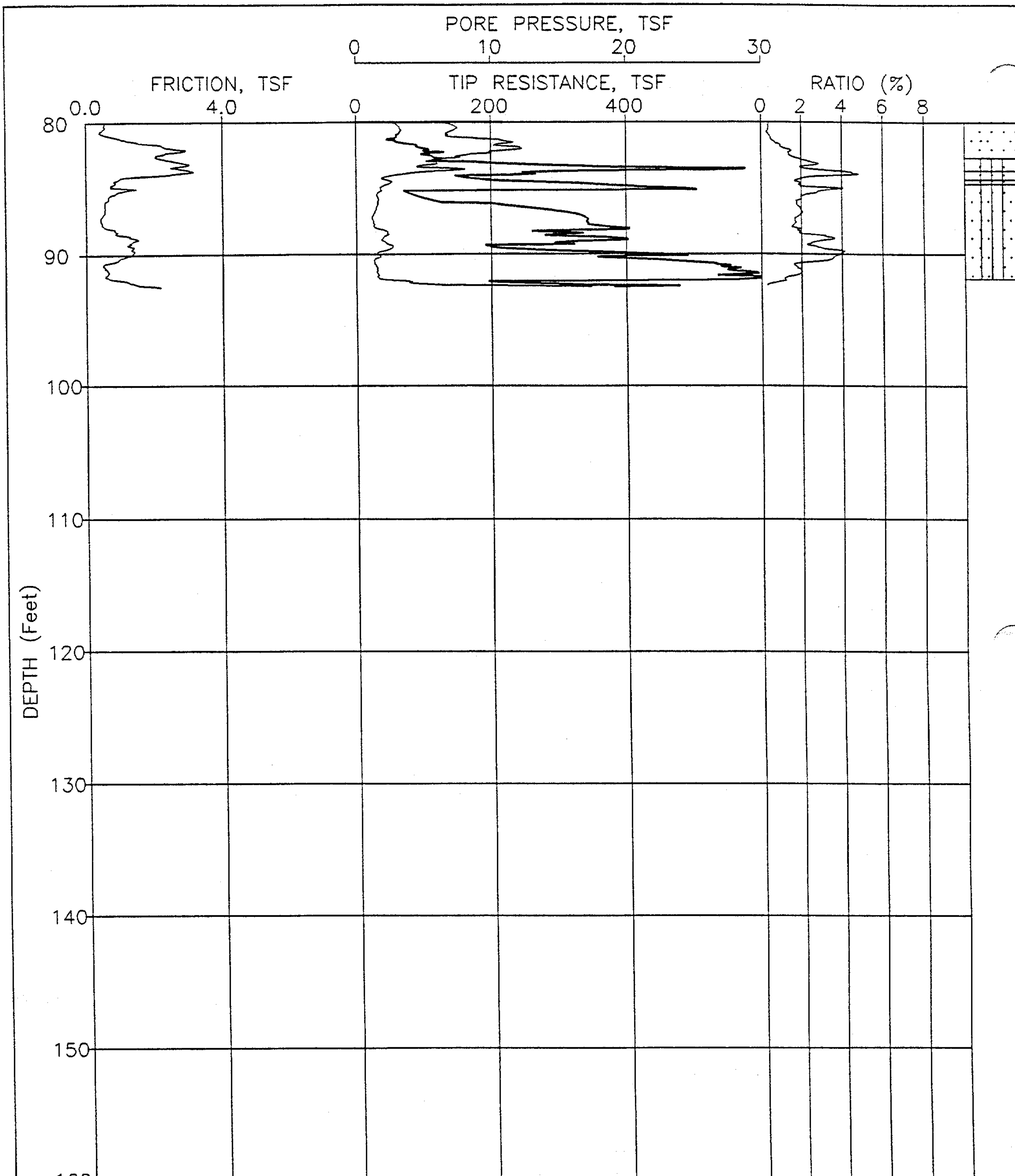
CONE NUMBER:F7.5CKEW169

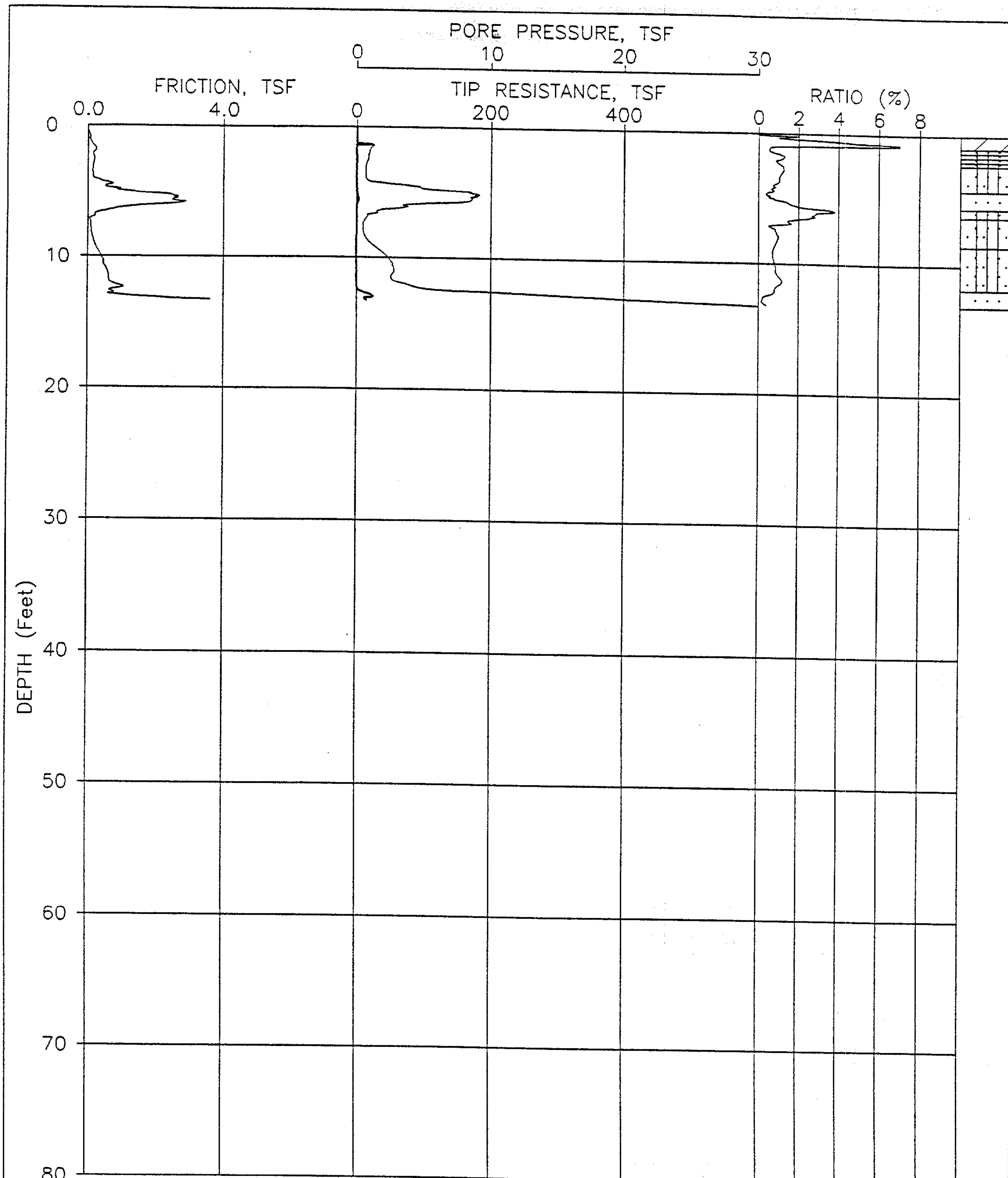
DATE: 05-04-1995
PLATE: 1 OF 2

FUGRO GEOSCIENCES,INC



JOB NUMBER: 95-5052
ELEVATION: 0.00
CPT NUMBER: U1P052
CONE NUMBER:F7.5CKEW169
DATE: 05-04-1995
PLATE: 2 OF 2

FUGRO GEOSCIENCES,INC

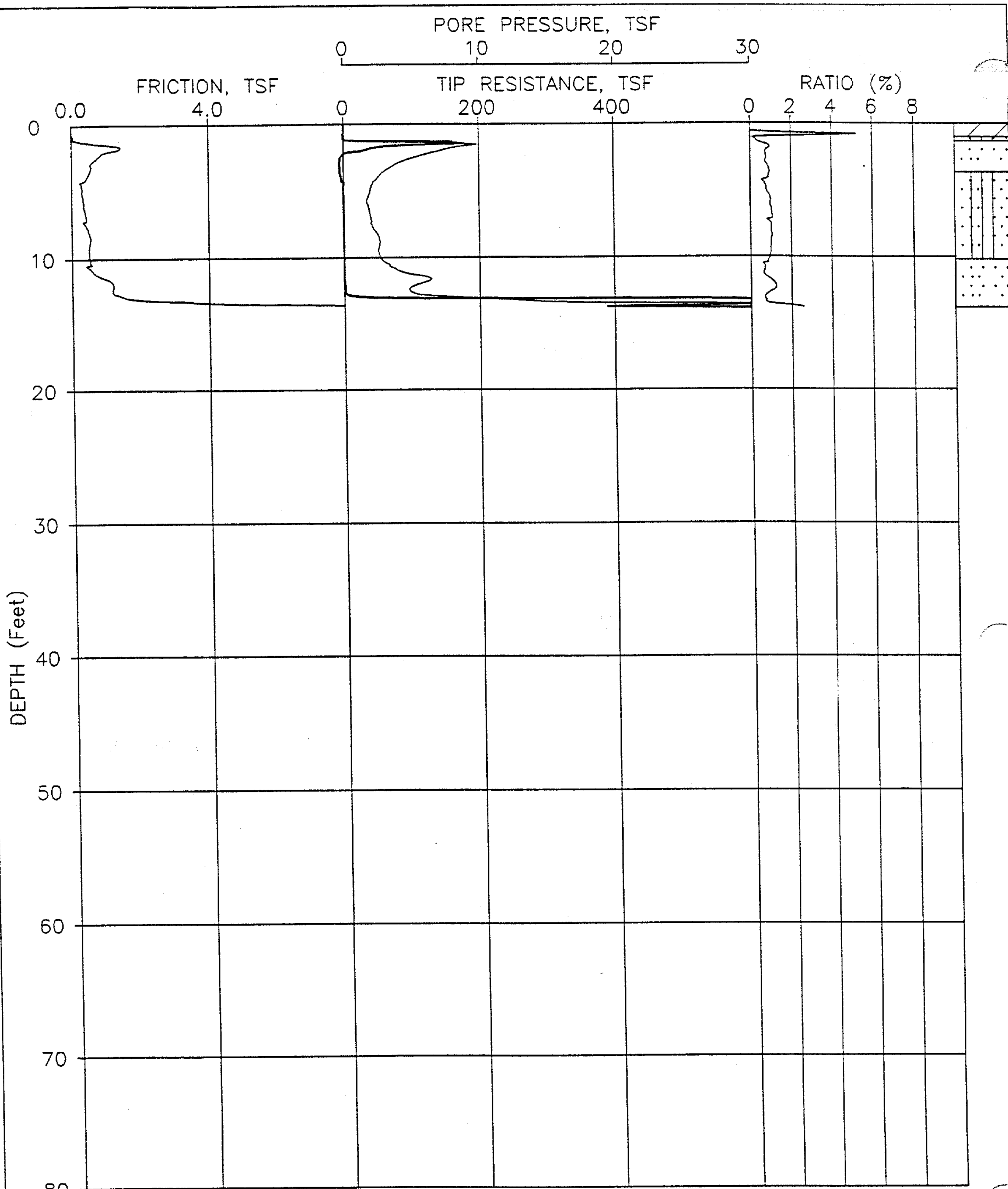


JOB NUMBER :95-5052
ELEVATION : 0.00

CPT NUMBER :U1P055
CONE NUMBER:F7.5CKEW169

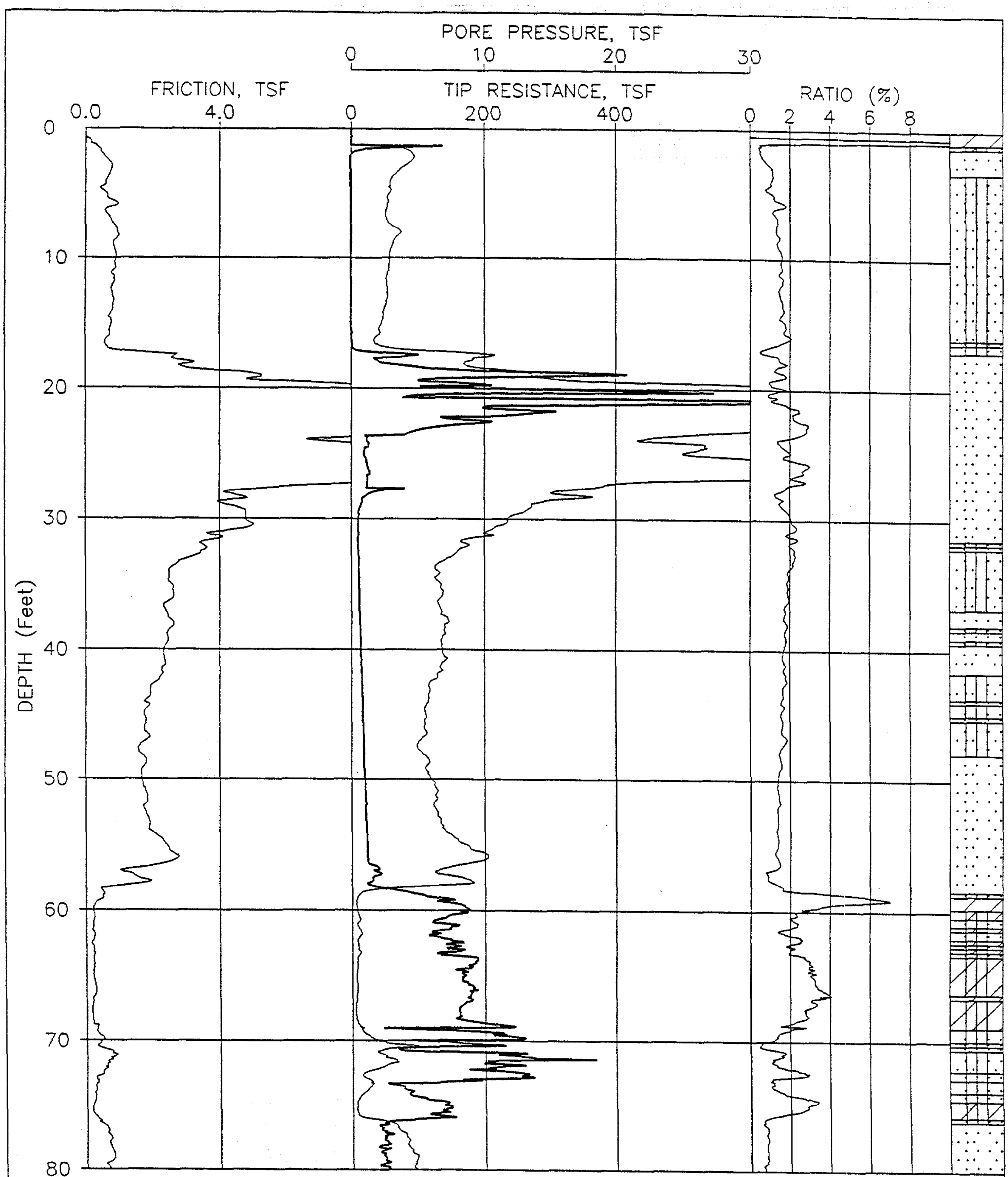
DATE : 05-04-1995

FUGRO GEOSCIENCES,INC



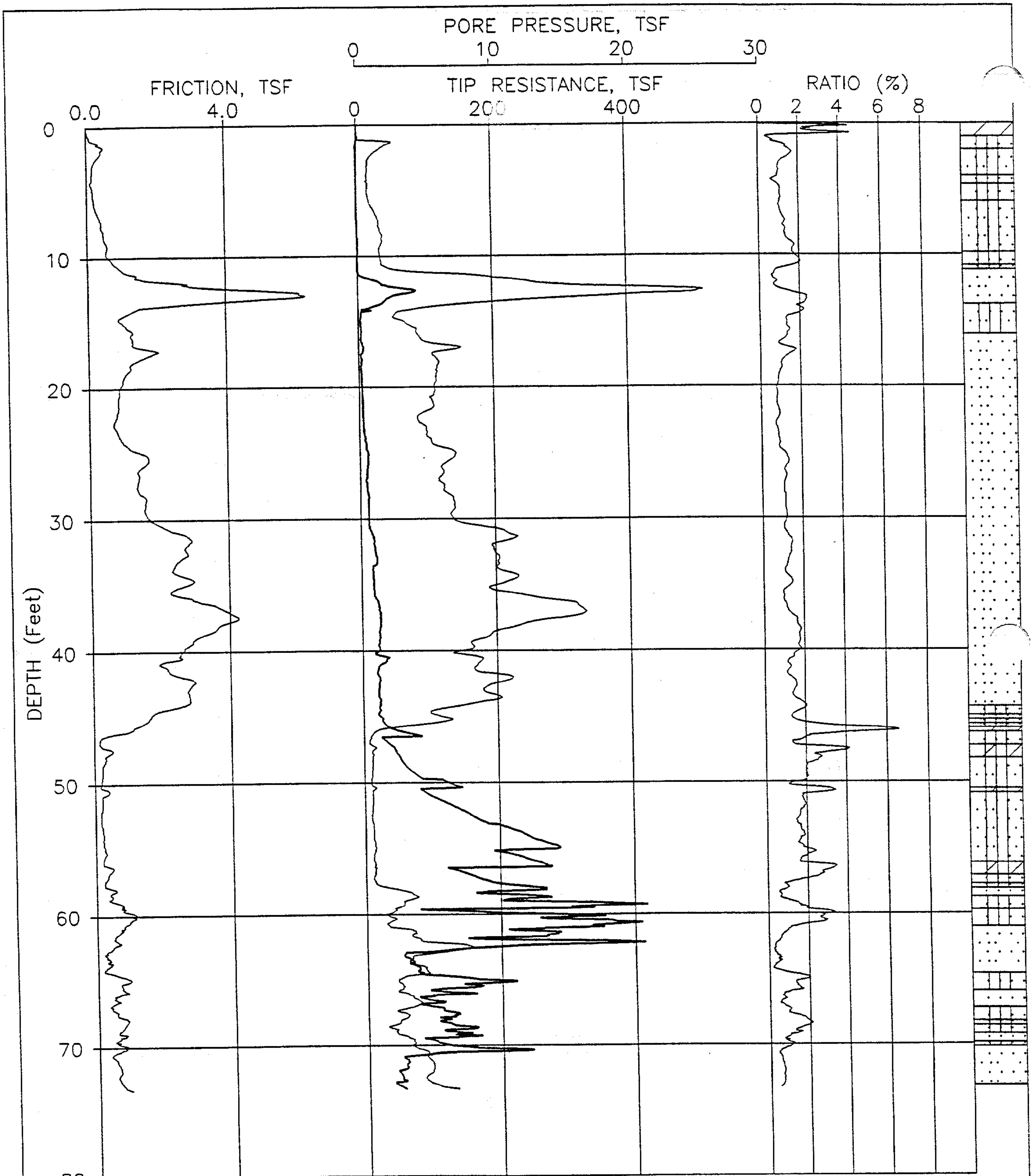
JOB NUMBER :95-5052
ELEVATION : 0.00
CPT NUMBER :U1P056
CONE NUMBER:F7.5CKEW169
DATE : 05-05-1995

FUGRO GEOSCIENCES,INC



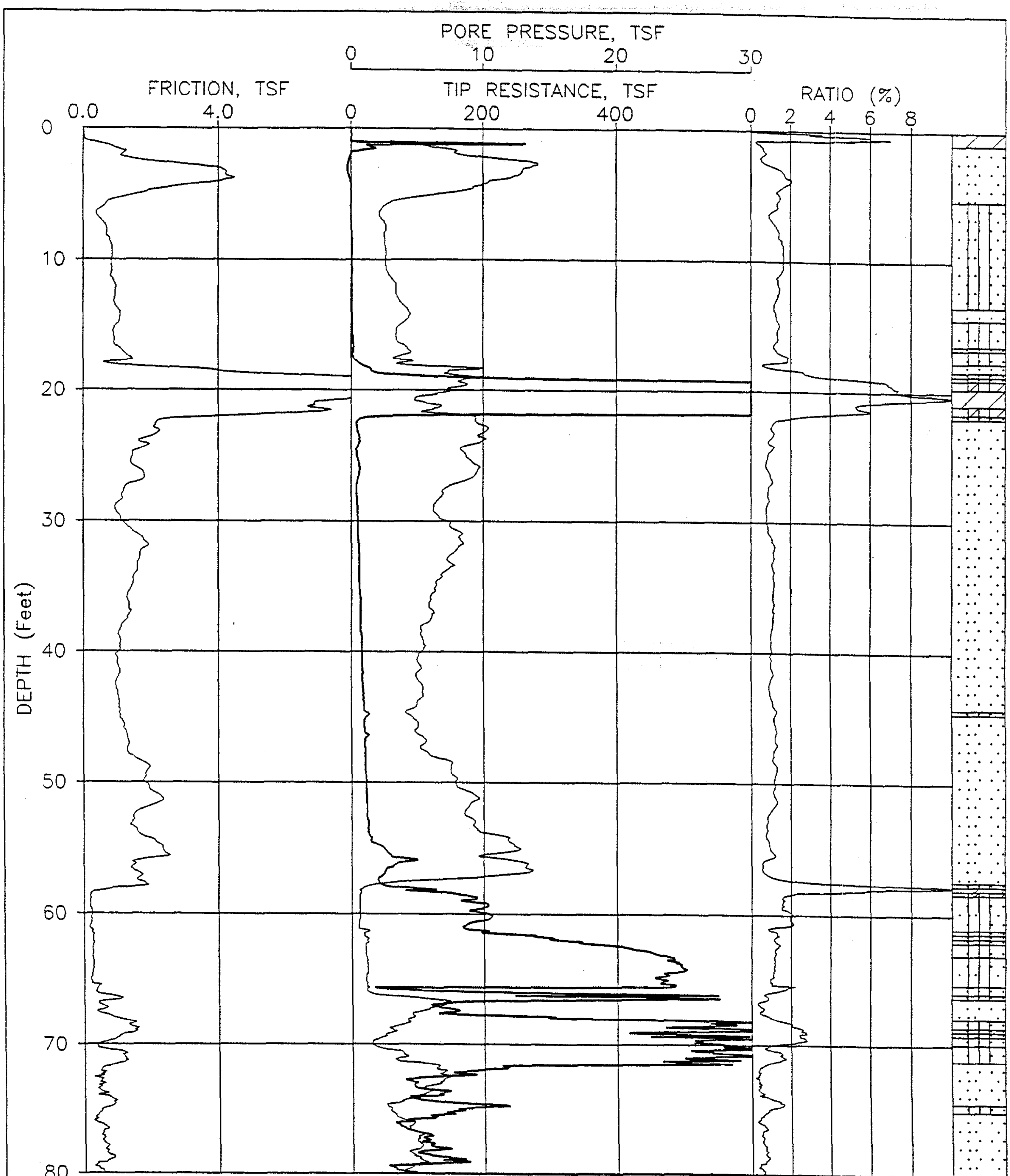
JOB NUMBER :95-5052
ELEVATION : 0.00
CPT NUMBER :U1P057
CONE NUMBER:F7.5CKEW169
DATE : 05-12-1995

FUGRO GEOSCIENCES,INC



JOB NUMBER :95-5052
ELEVATION : 0.00
CPT NUMBER :U1P058
CONE NUMBER:F7.5CKEW169
DATE : 05-13-1995

FUGRO GEOSCIENCES,INC

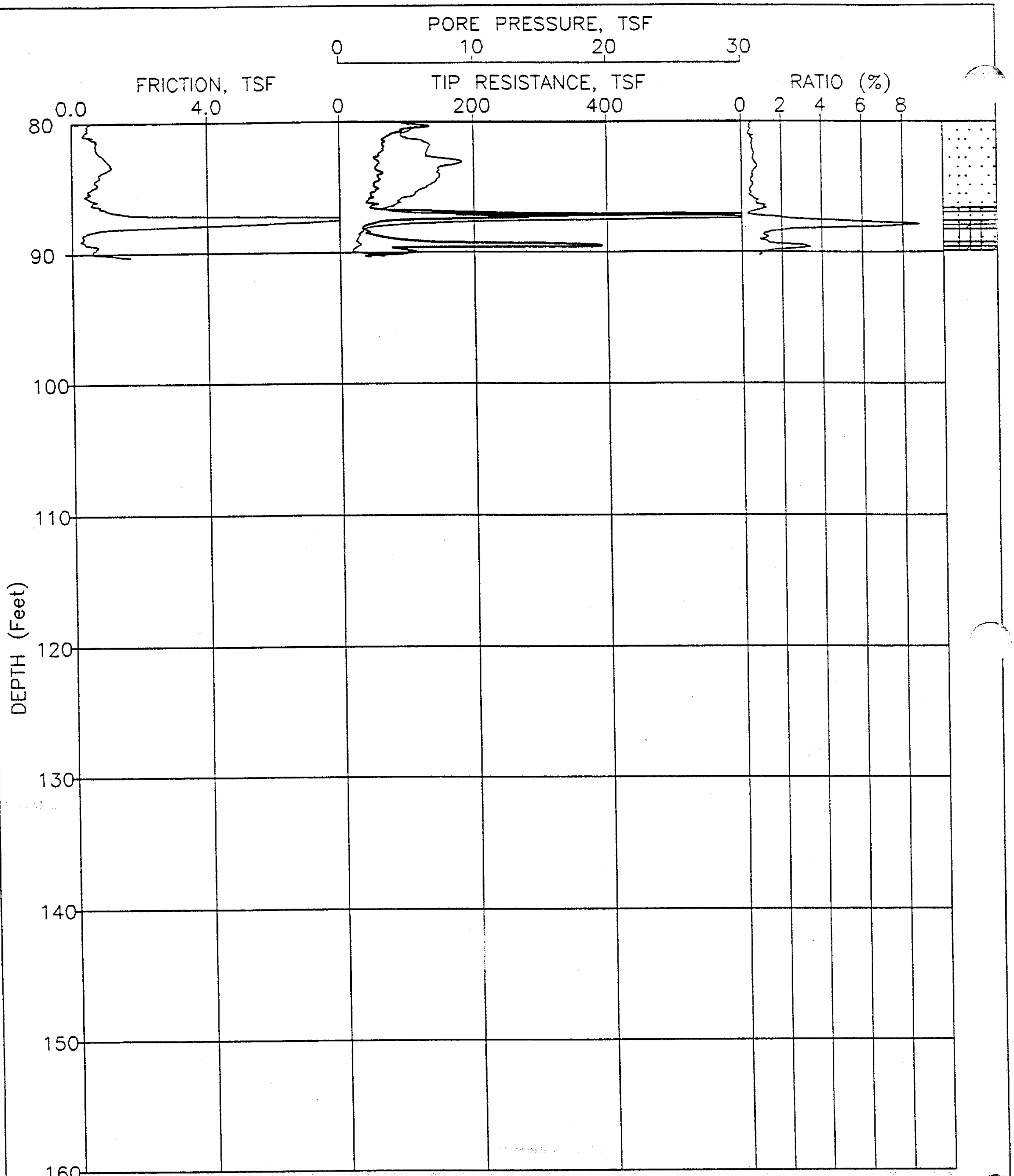


JOB NUMBER: 95-5052
ELEVATION: 0.00

CPT NUMBER: U1P059
CONE NUMBER:F7.5CKEW169

DATE: 05-13-1995
PLATE: 1 OF 2

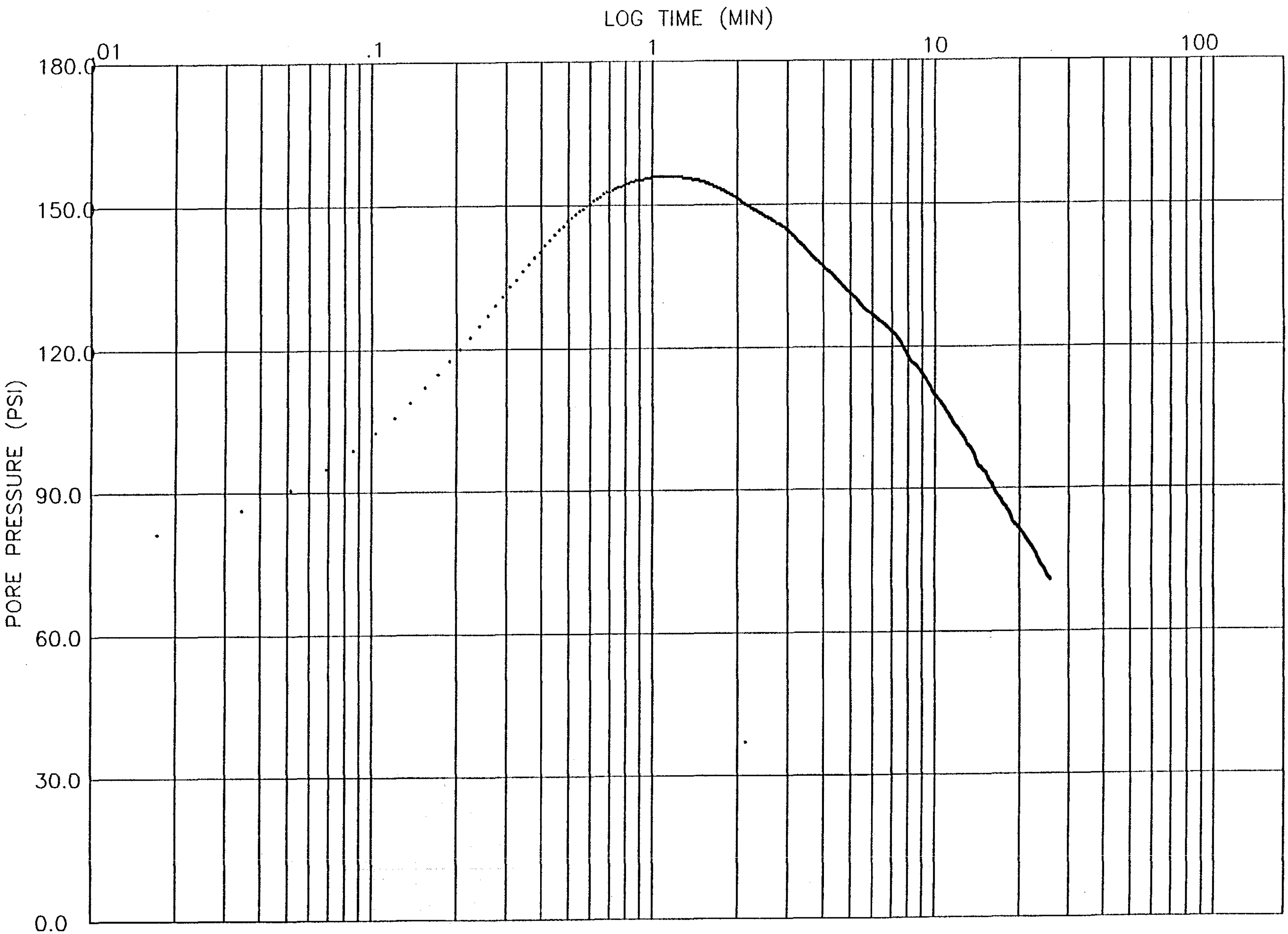
FUGRO GEOSCIENCES,INC



JOB NUMBER: 95-5052
ELEVATION: 0.00
CPT NUMBER: U1P059
CONE NUMBER:F7.5CKEW169
DATE: 05-13-1995
PLATE: 2 OF 2

FUGRO GEOSCIENCES,INC

DISSIPATION TESTS

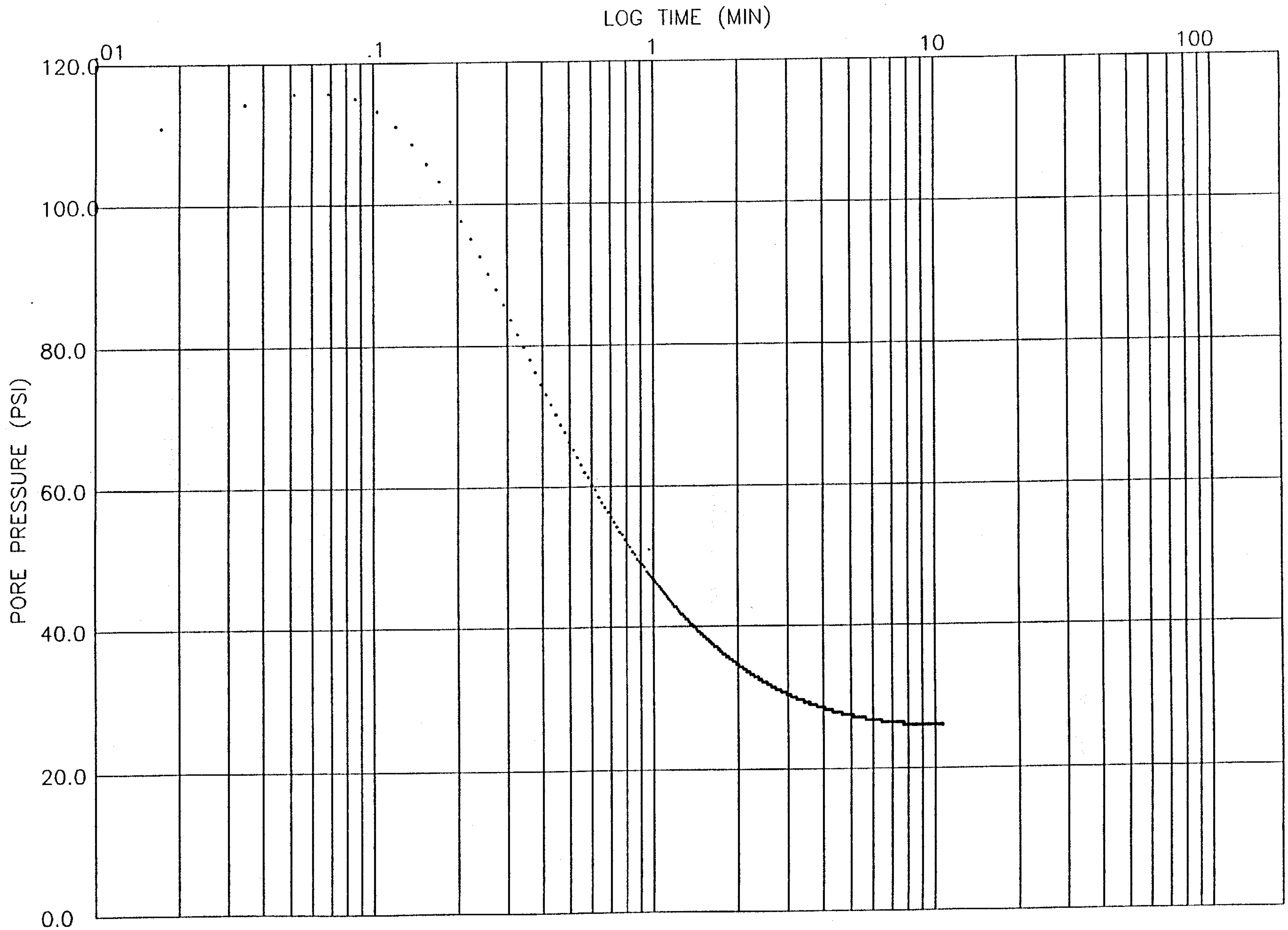


CPT NUMBER: U1P009
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 58.7 FEET
DATE: 05-12-1995

FUGRO GEOSCIENCES, INC.

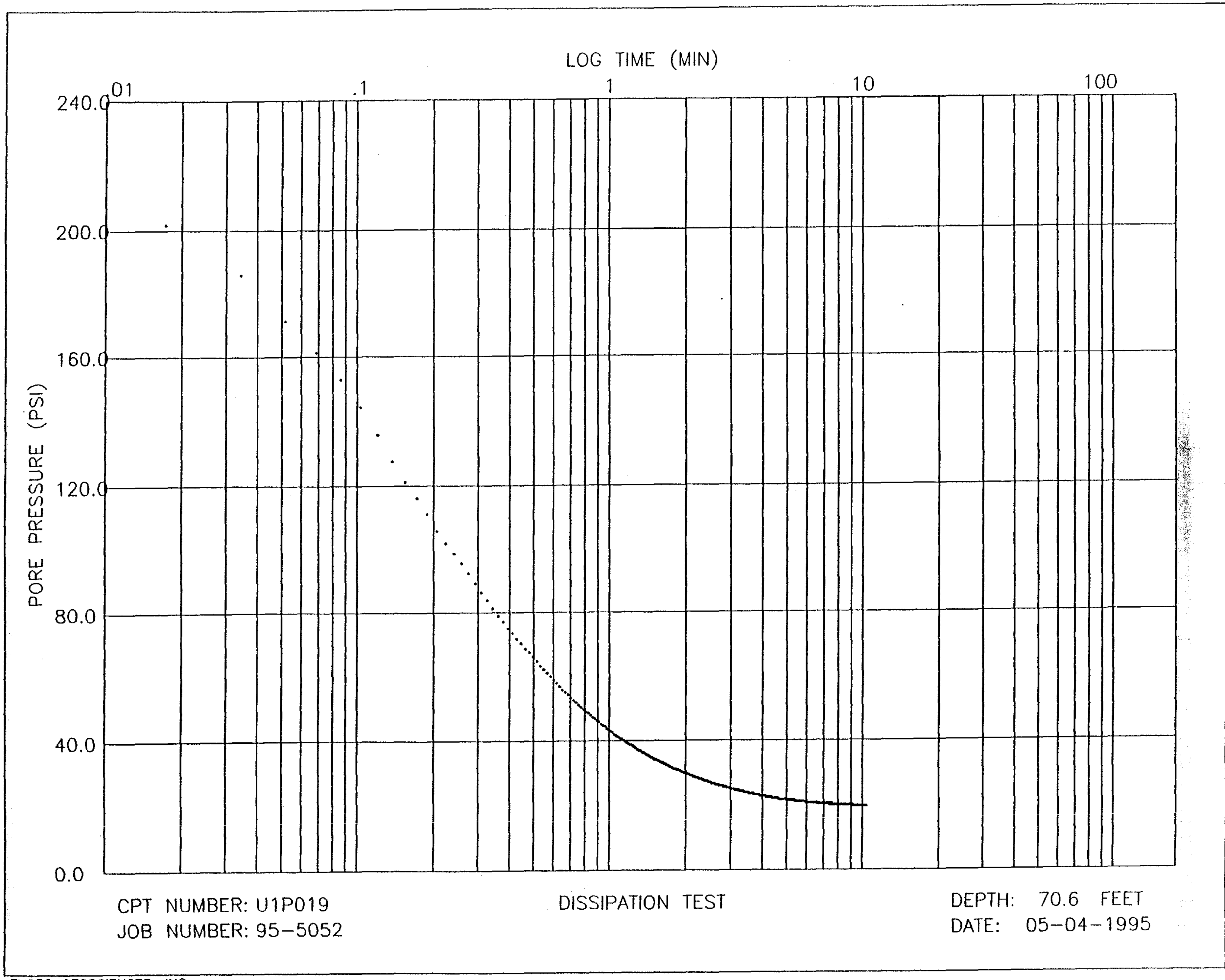


CPT NUMBER: U1P009
JOB NUMBER: 95-5052

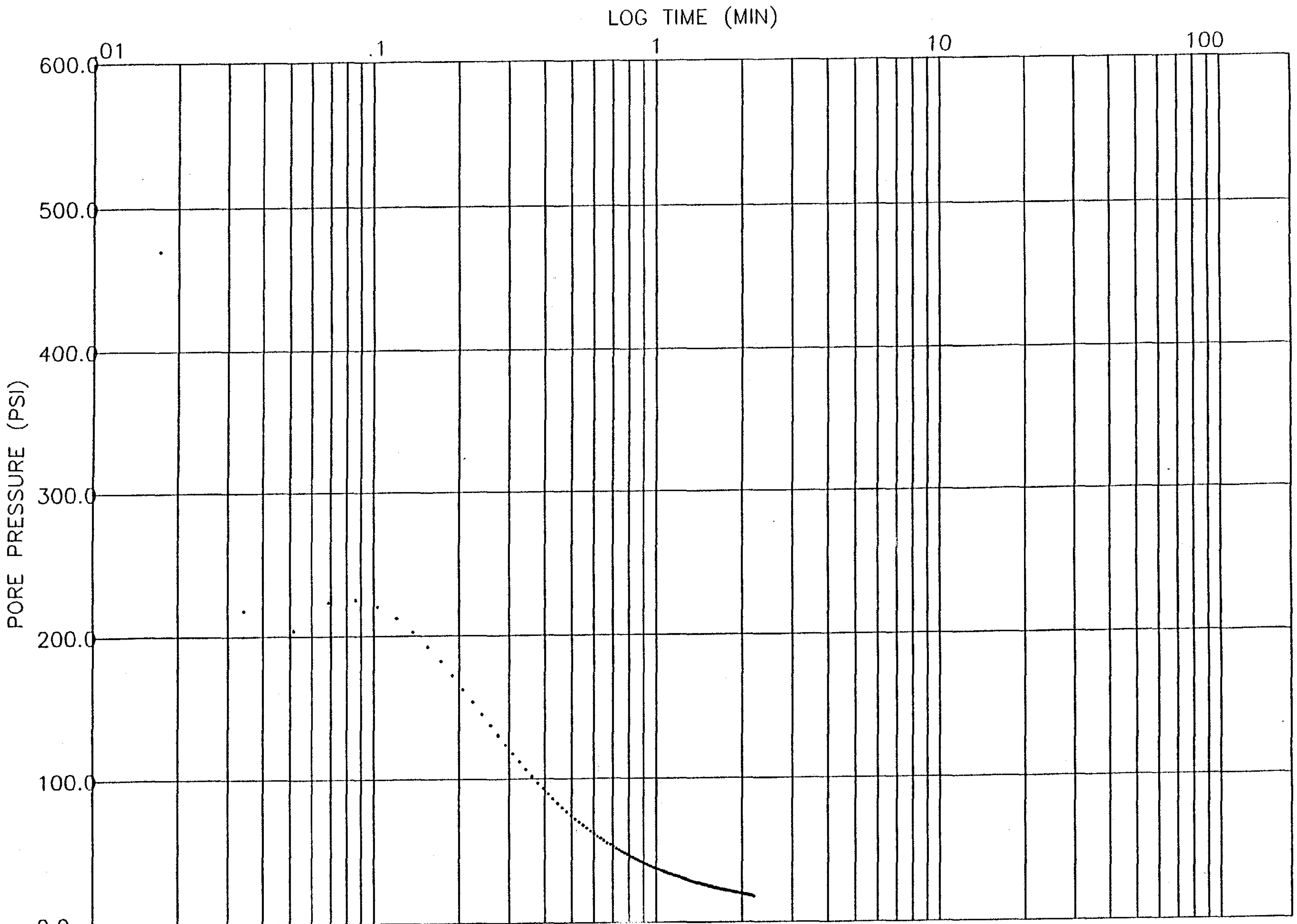
DISSIPATION TEST

DEPTH: 79.4 FEET
DATE: 05-12-1995

FUGRO GL ·IENCES, INC.



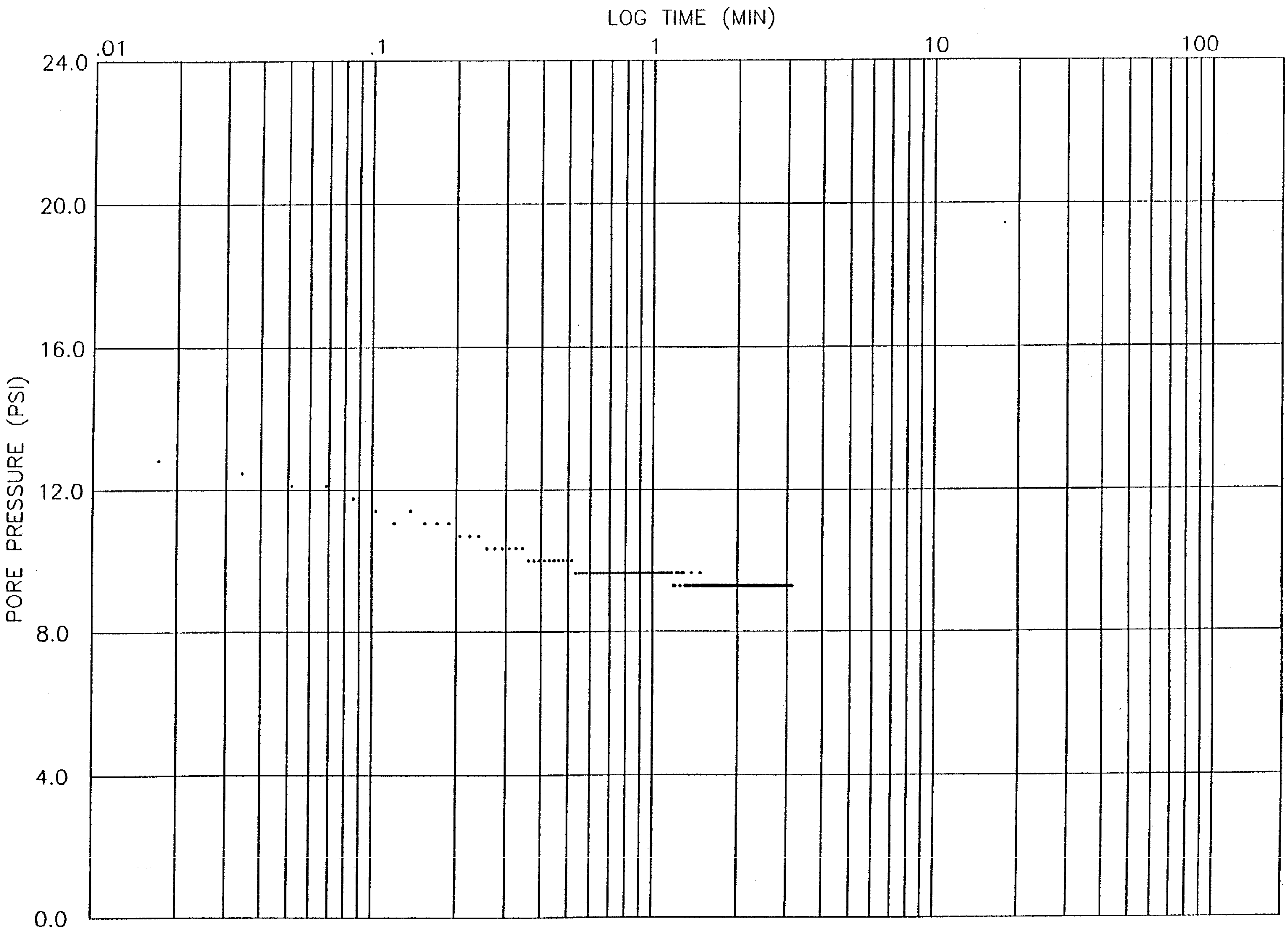
FUGRO GEOSCIENCES, INC.



CPT NUMBER: U1P021
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 14.8 FEET
DATE: 05-03-1995

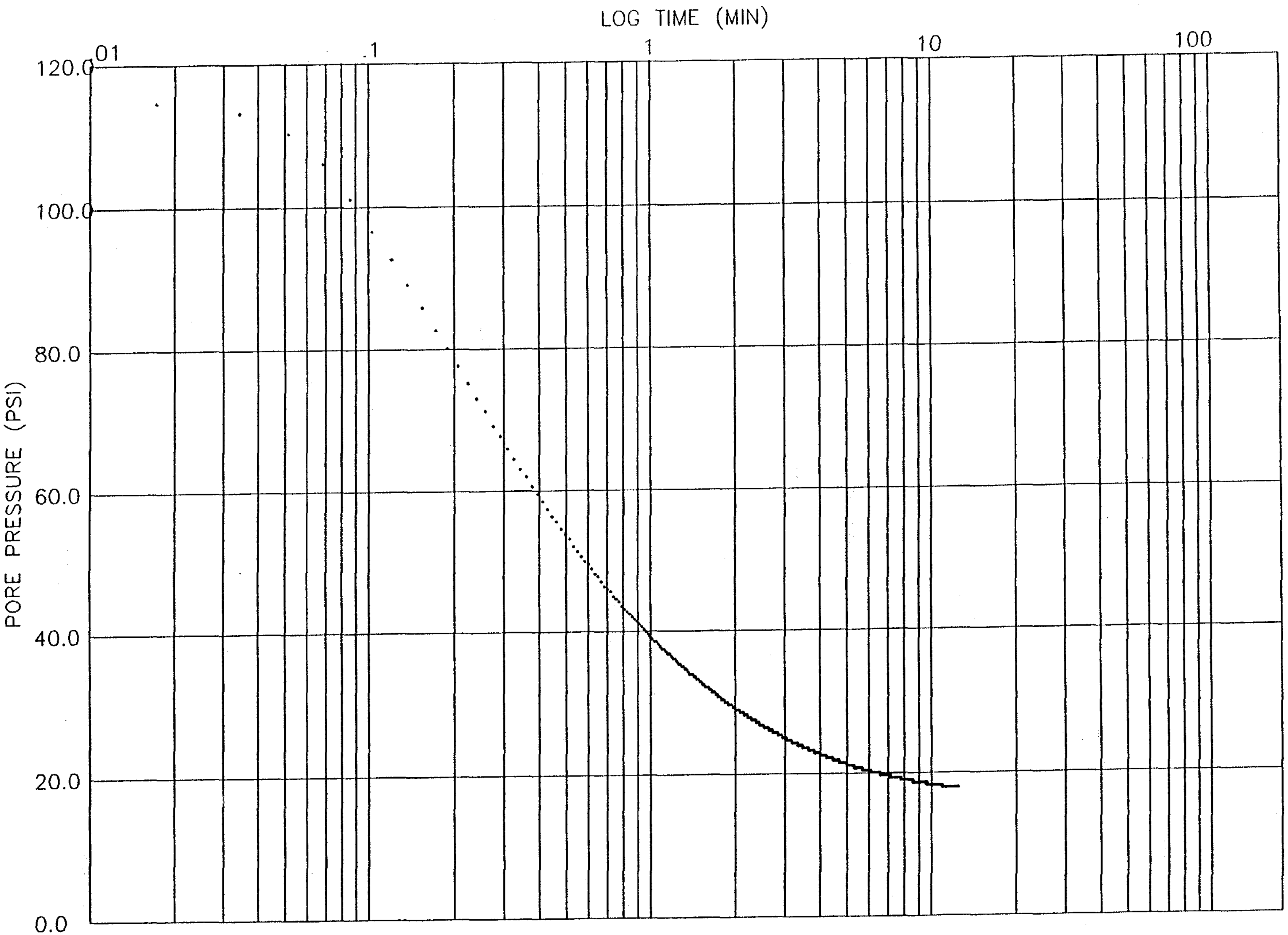


CPT NUMBER: U1P033
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 40.3 FEET
DATE: 05-03-1995

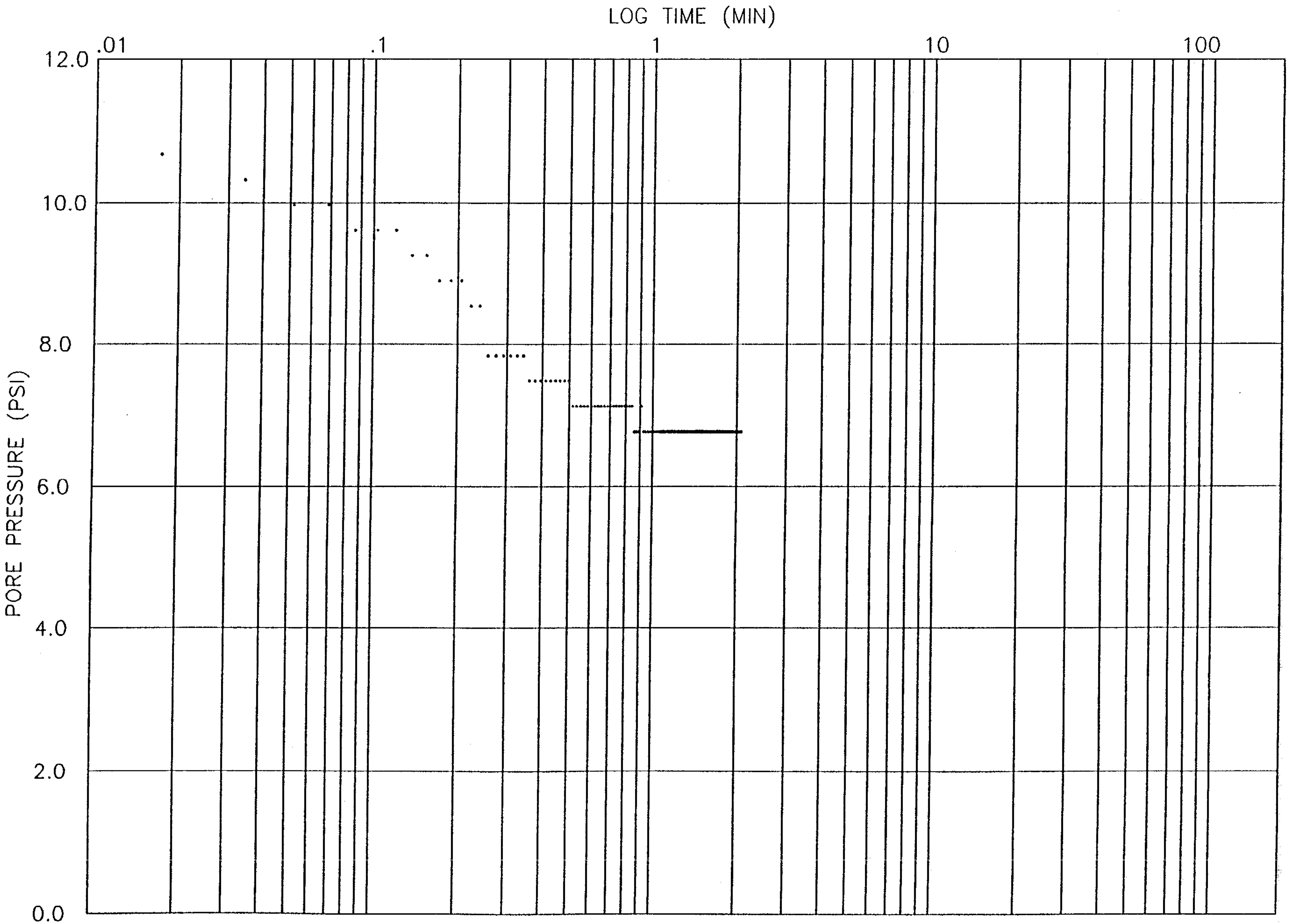
FUGRO GEOSCIENCES, INC.



CPT NUMBER: U1P033
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 58.6 FEET
DATE: 05-03-1995

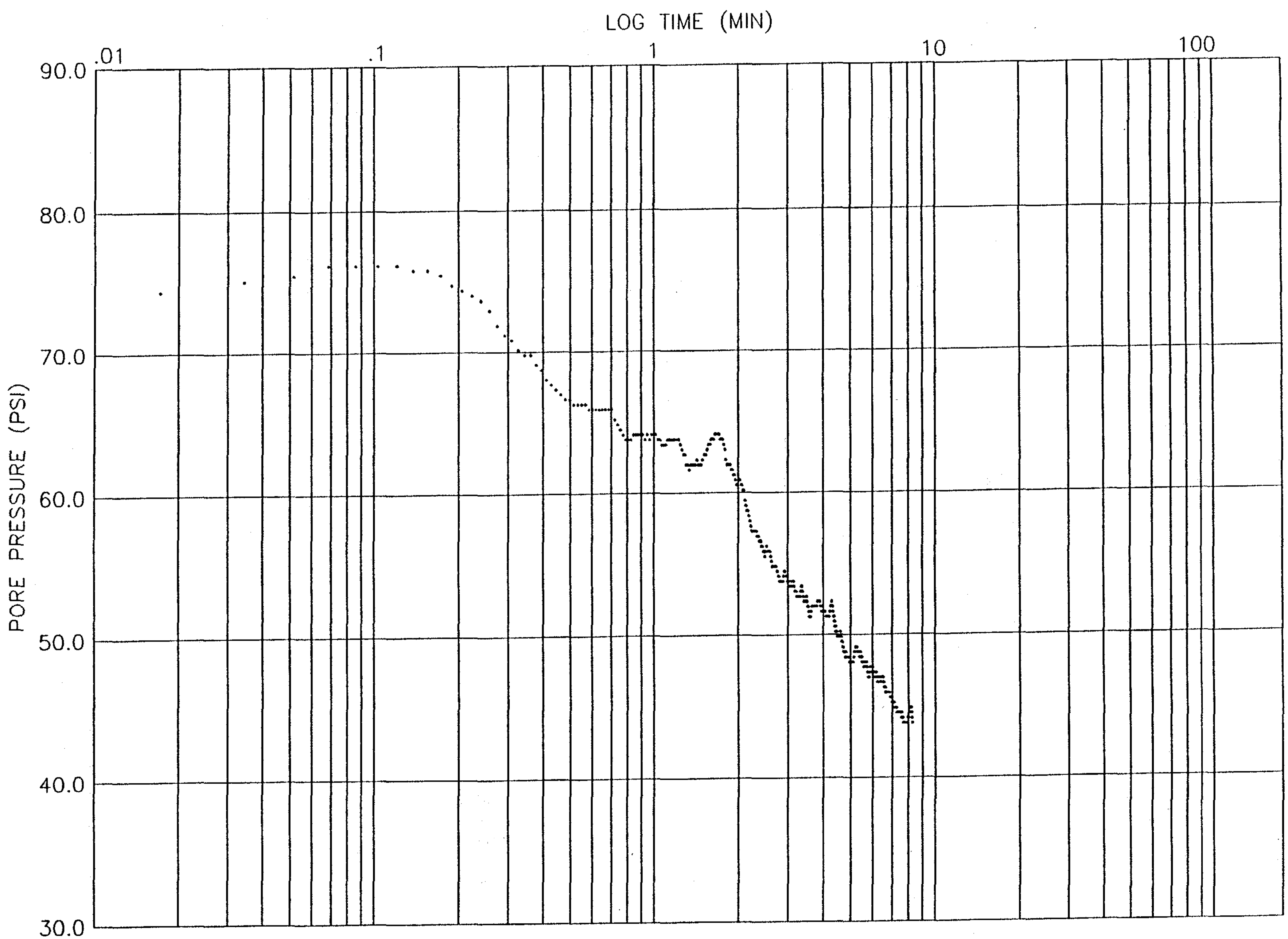


CPT NUMBER: U1P039
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 32.7 FEET
DATE: 05-04-1995

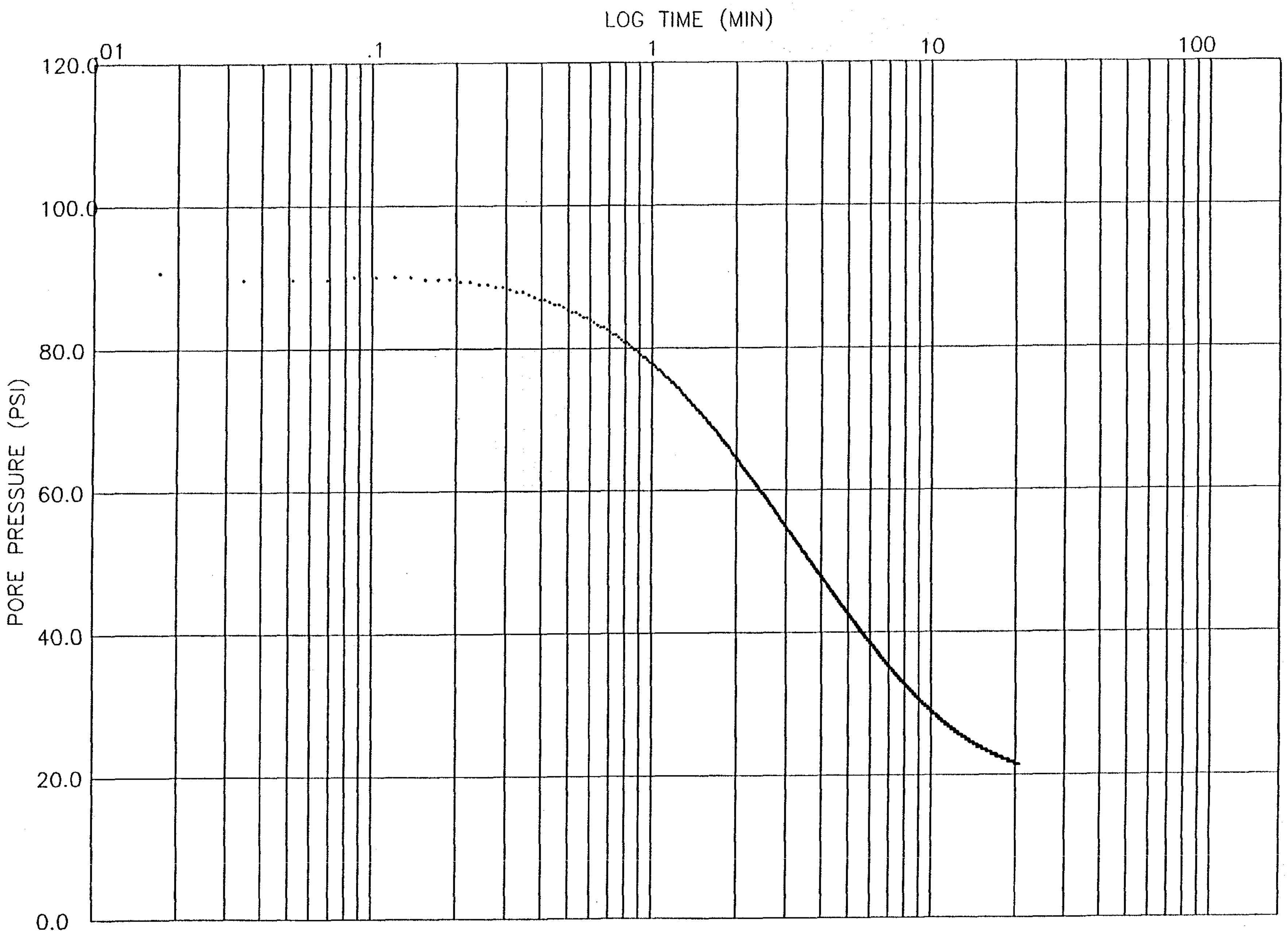
FUGRO GEOSCIENCES, INC.



CPT NUMBER: U1P039
JOB NUMBER: 95-5052

DISSIPATION TEST

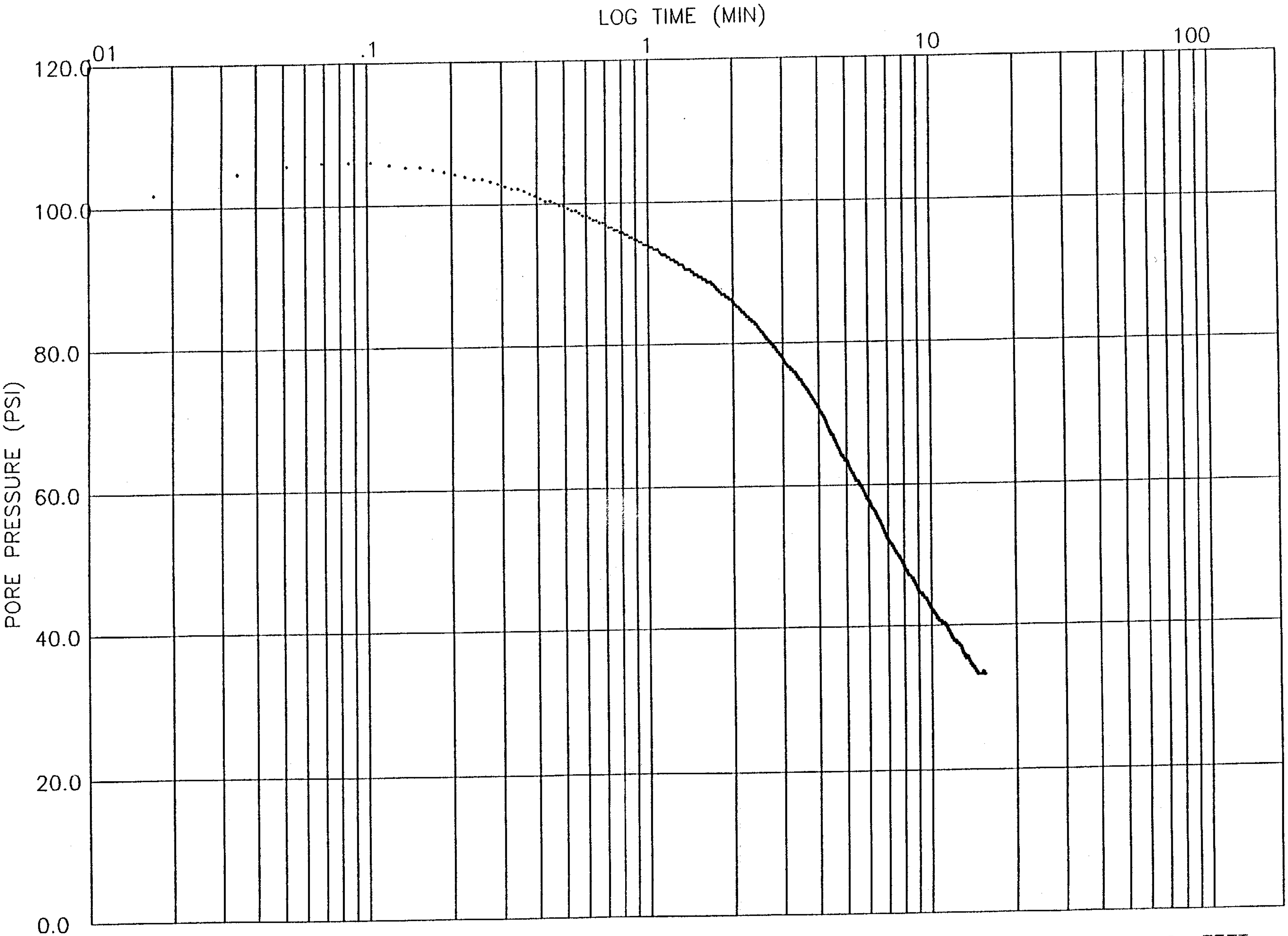
DEPTH: 60.4 FEET
DATE: 05-04-1995



CPT NUMBER: U1P039
JOB NUMBER: 95-5052

DISSIPATION TEST

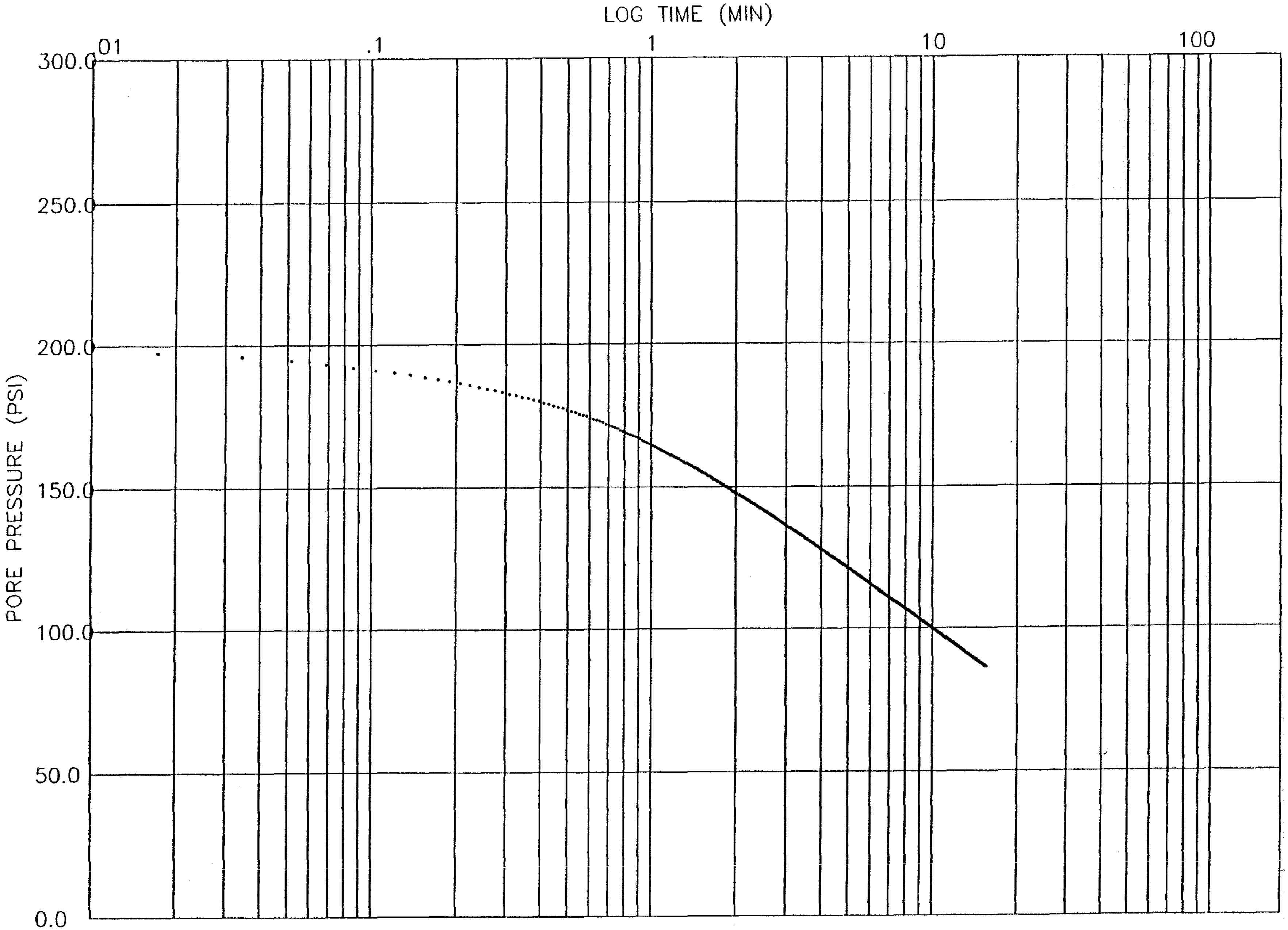
DEPTH: 61.5 FEET
DATE: 05-04-1995



CPT NUMBER: U1P048
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 50.2 FEET
DATE: 05-04-1995

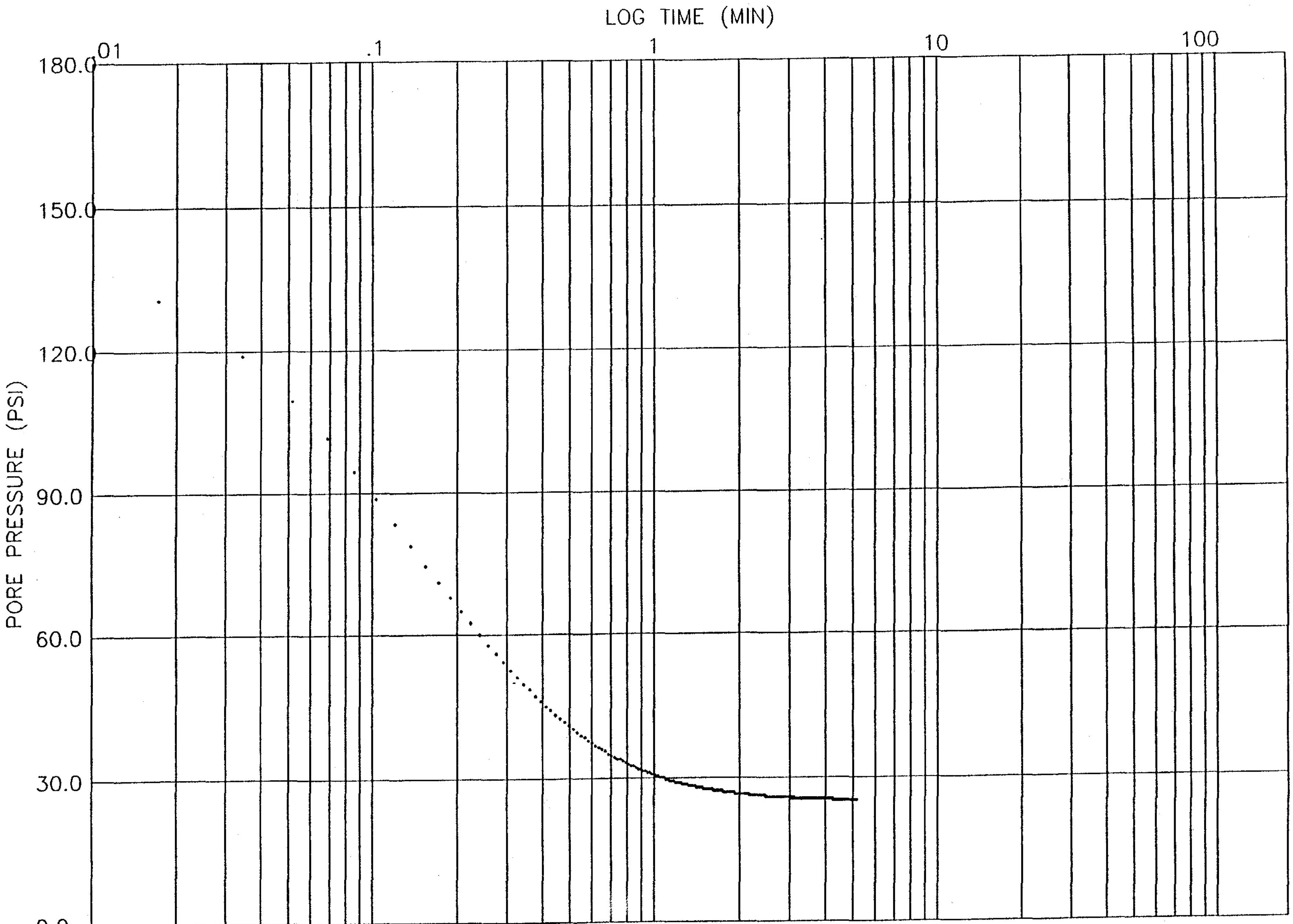


CPT NUMBER: U1P048
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 59.5 FEET
DATE: 05-04-1995

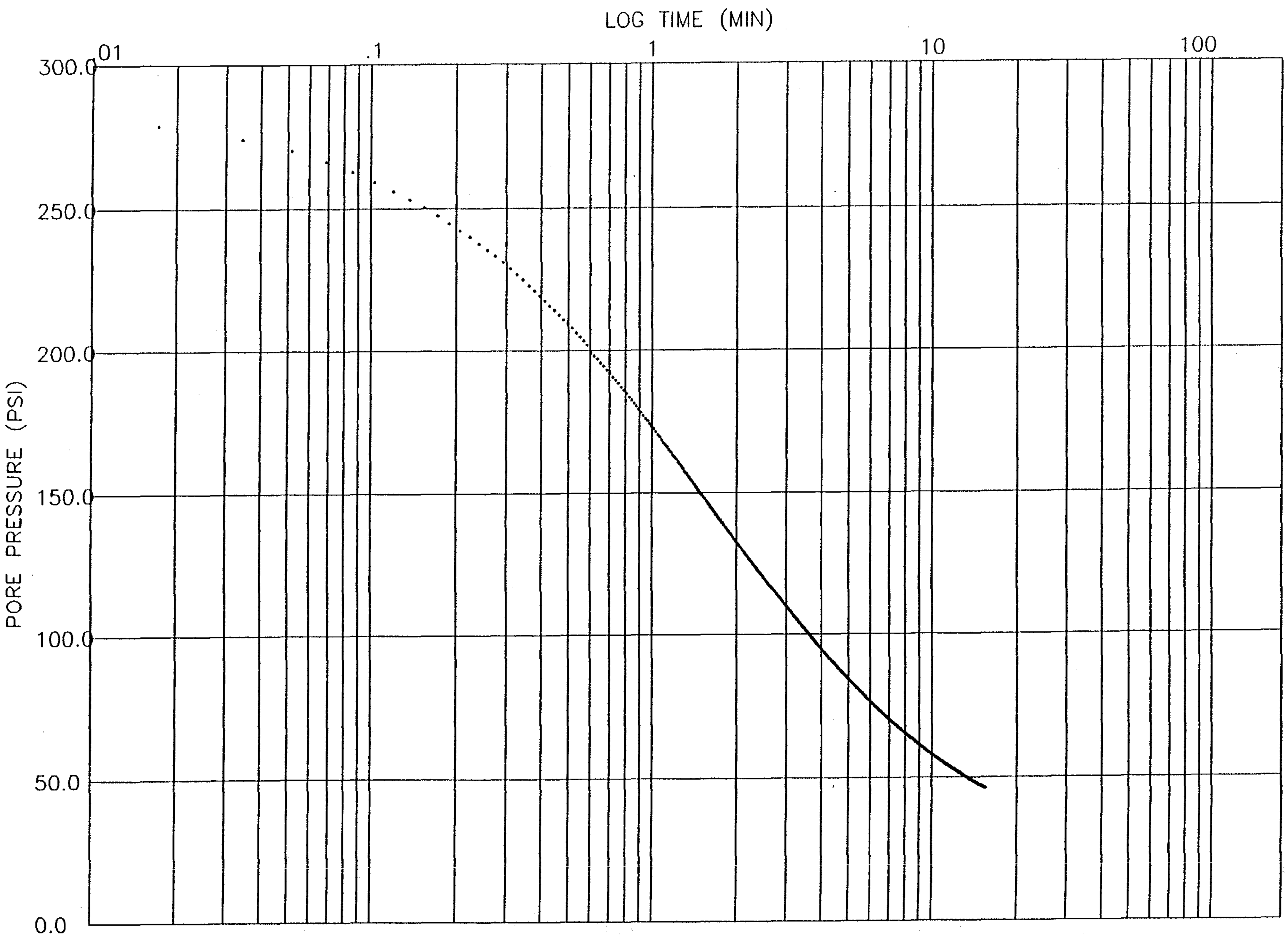
FUGRO GEOSCIENCES, INC.



CPT NUMBER: U1P048
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 79.9 FEET
DATE: 05-04-1995

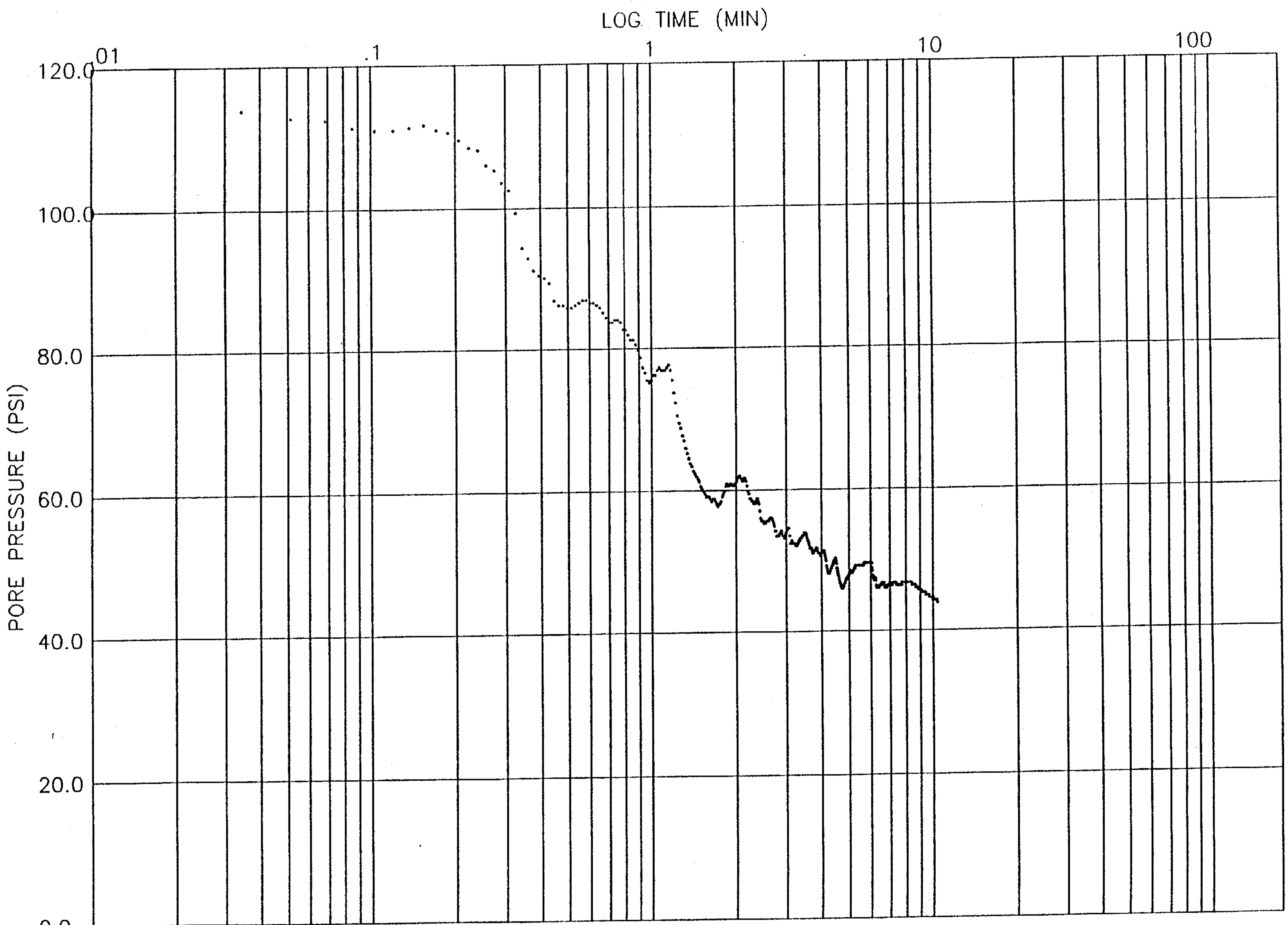


CPT NUMBER: U1P048
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 81.1 FEET
DATE: 05-04-1995

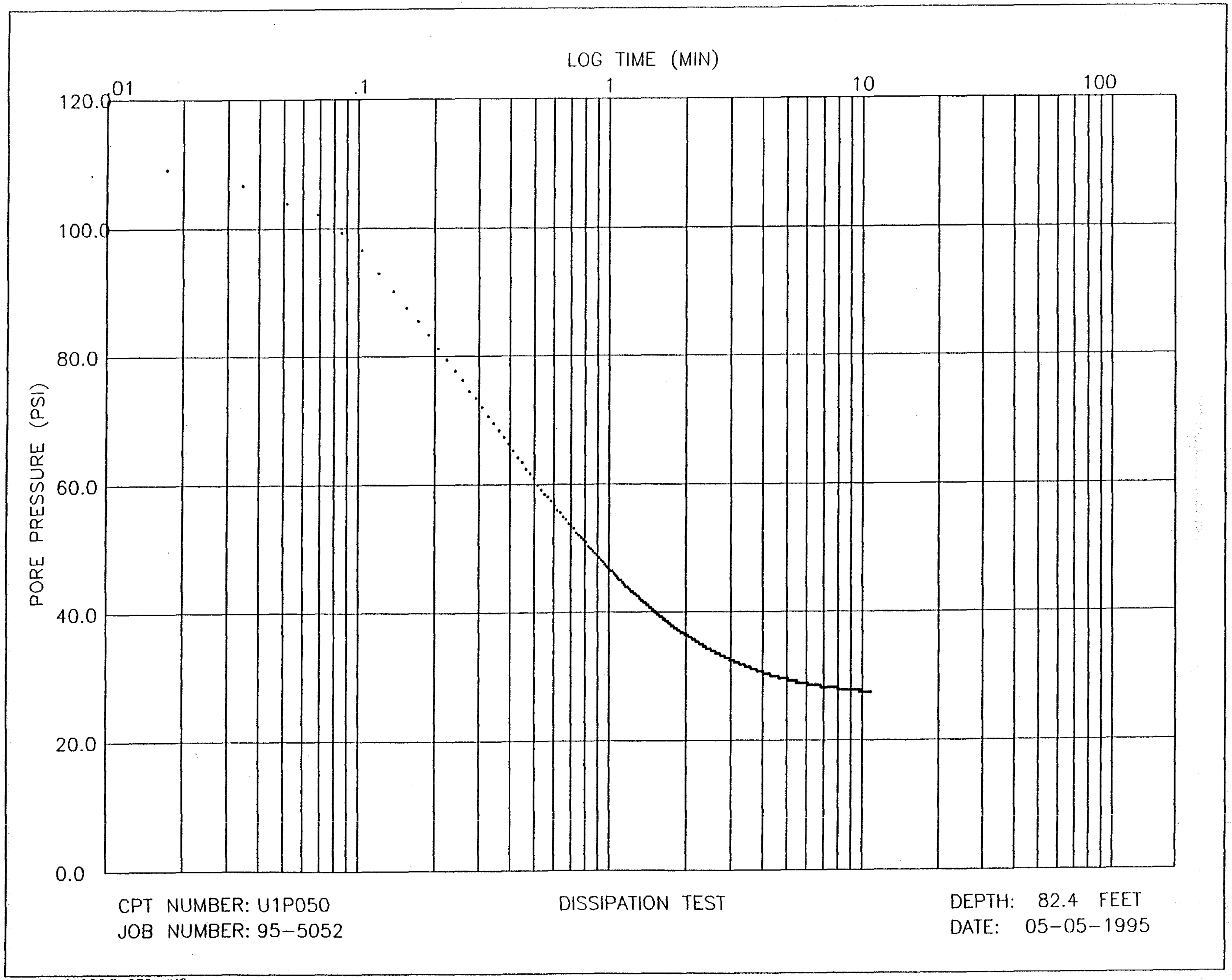
FUGRO GEOSCIENCES, INC.



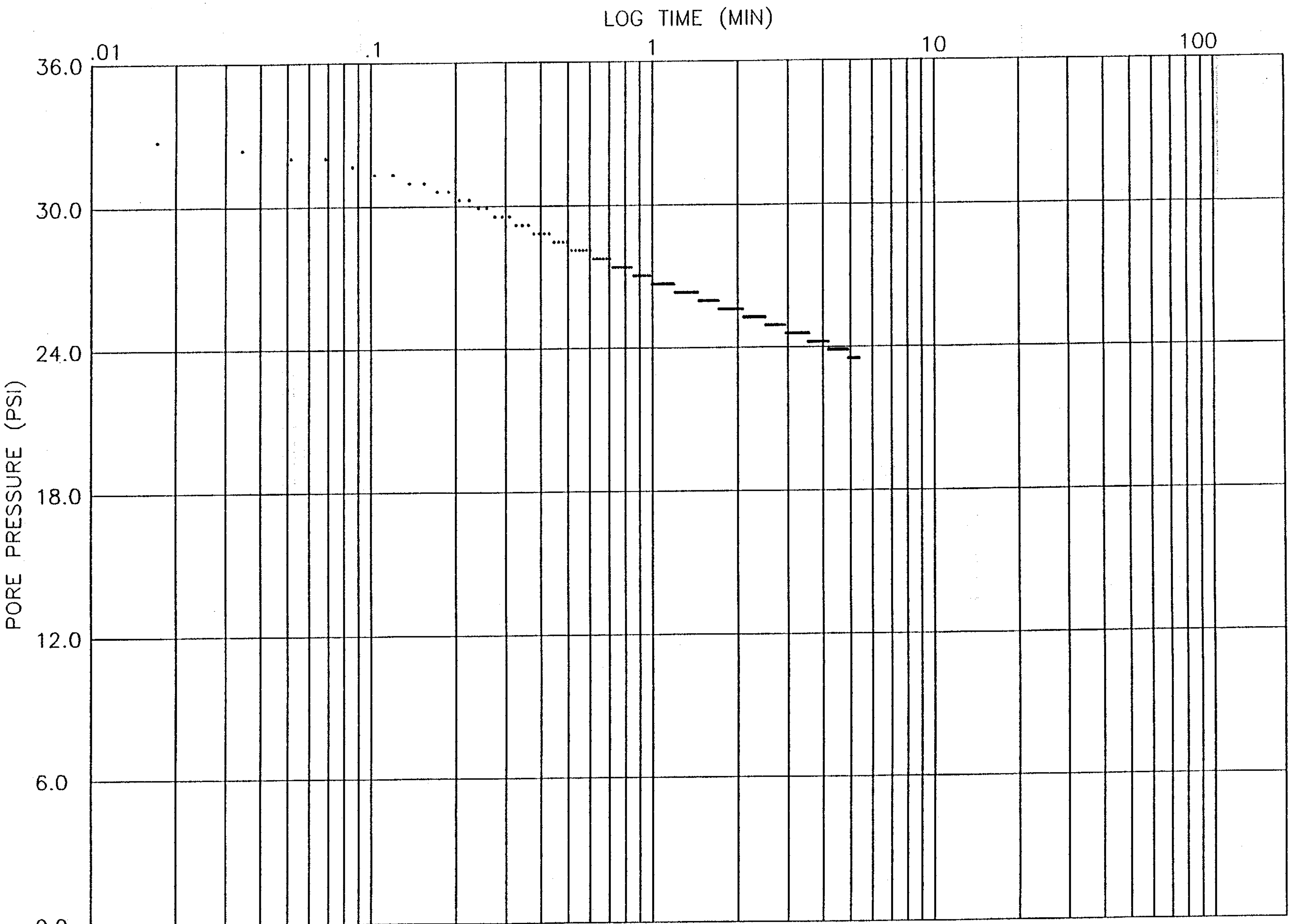
CPT NUMBER: U1P050
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 69.4 FEET
DATE: 05-05-1995



FUGRO GEOSCIENCES, INC.

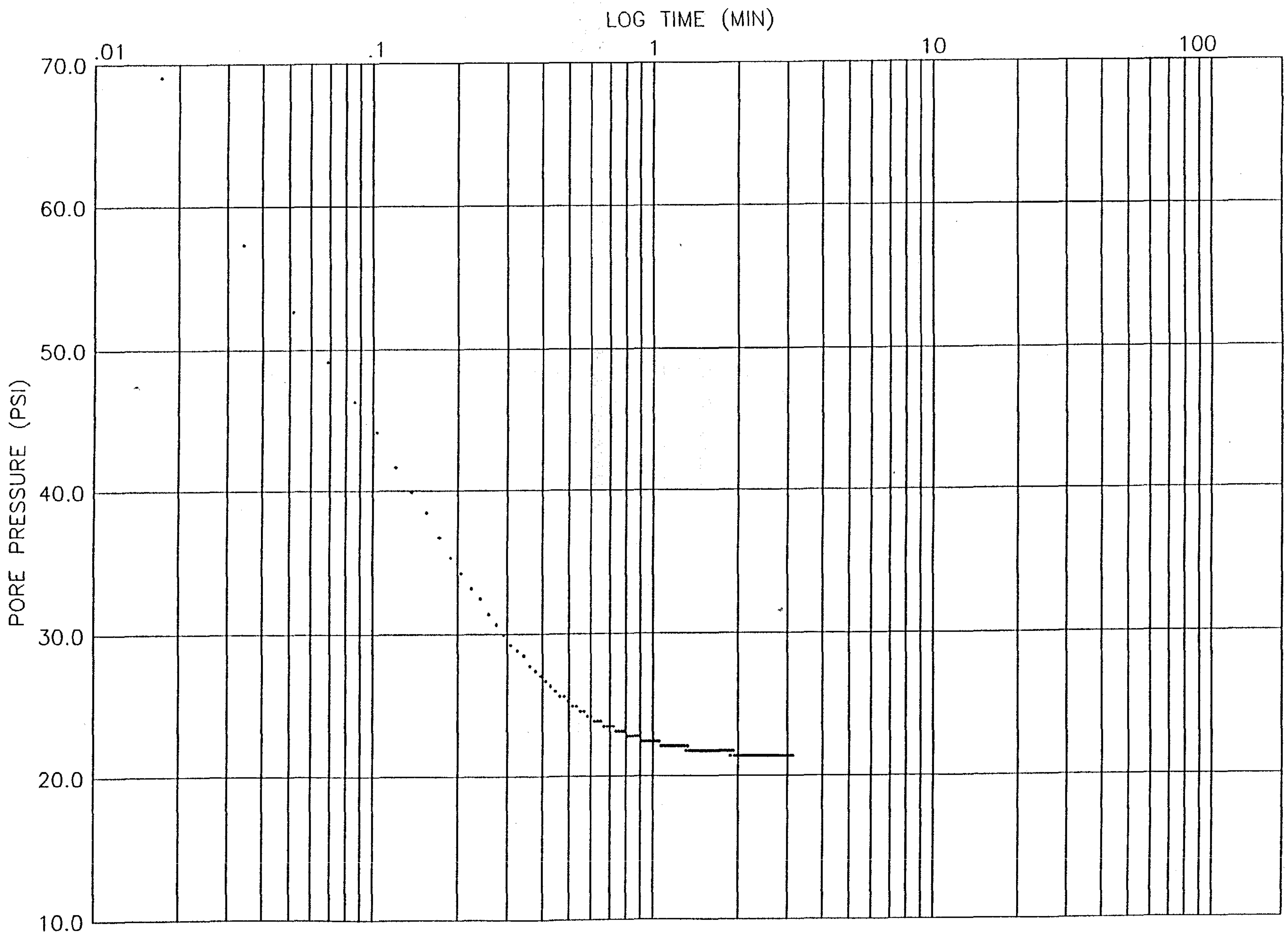


CPT NUMBER: U1P052
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 65.2 FEET
DATE: 05-04-1995

FUGRO GE... ENCES, INC.

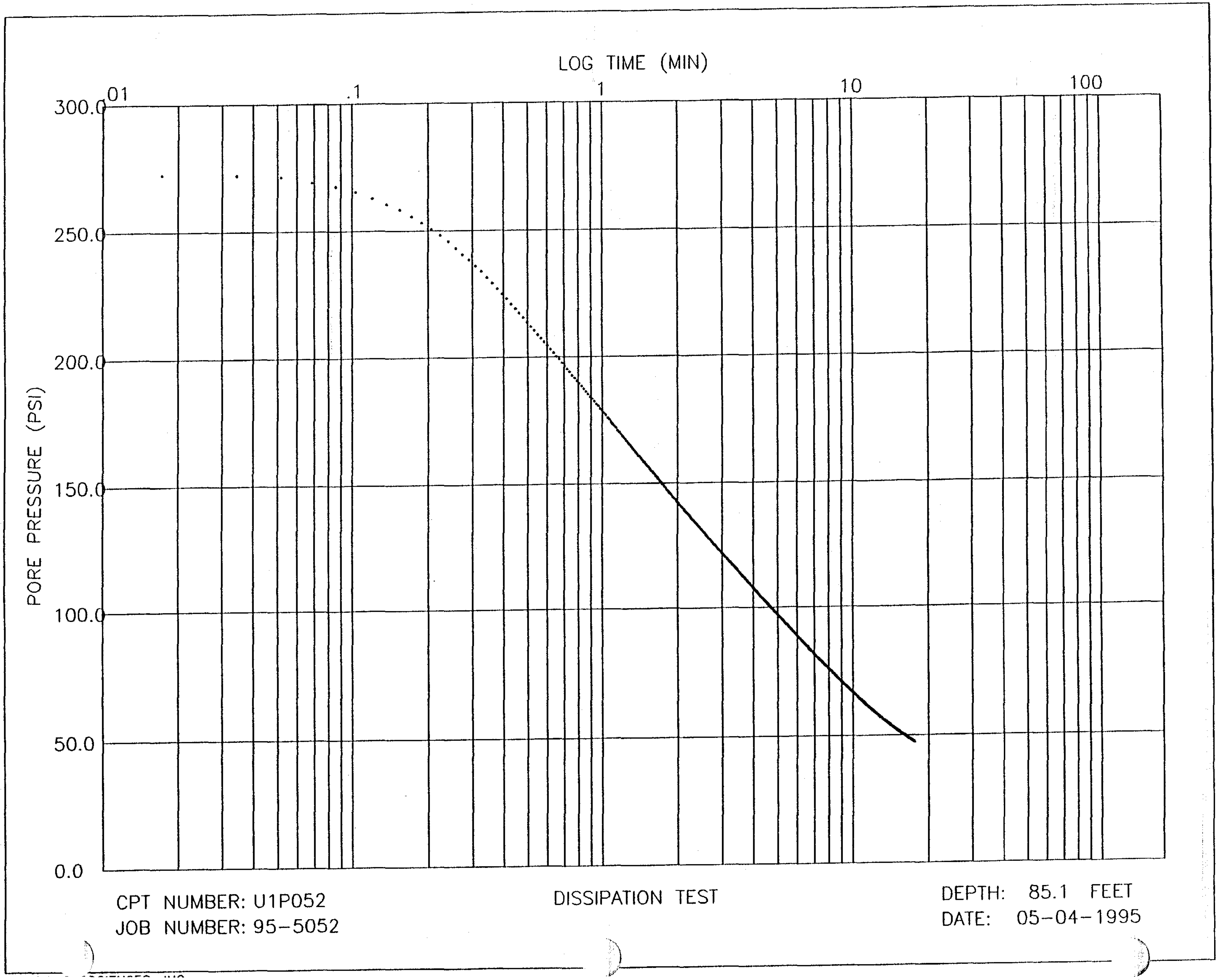


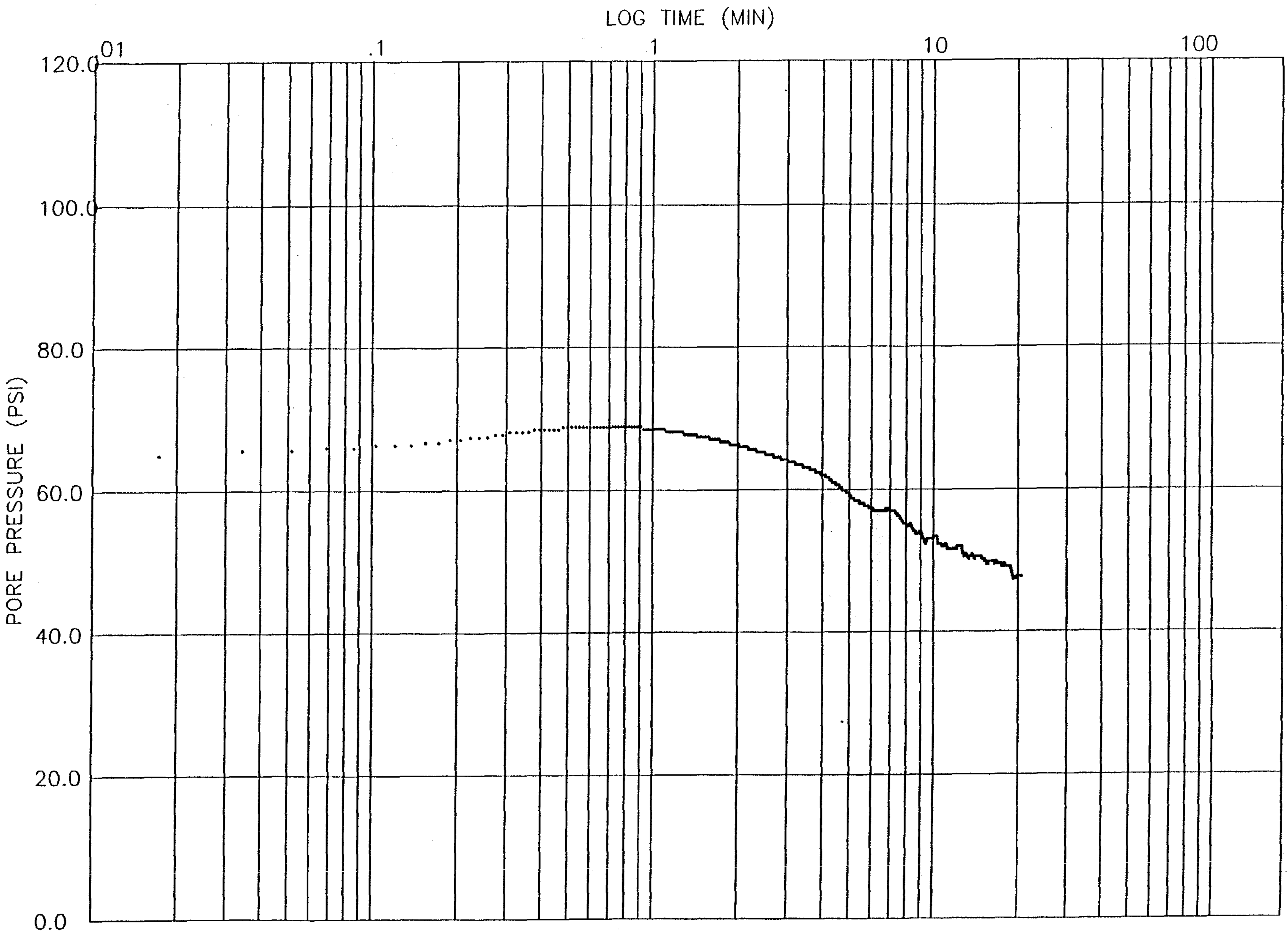
CPT NUMBER: U1P052
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 72.8 FEET
DATE: 05-04-1995

FUGRO GEOSCIENCES, INC.

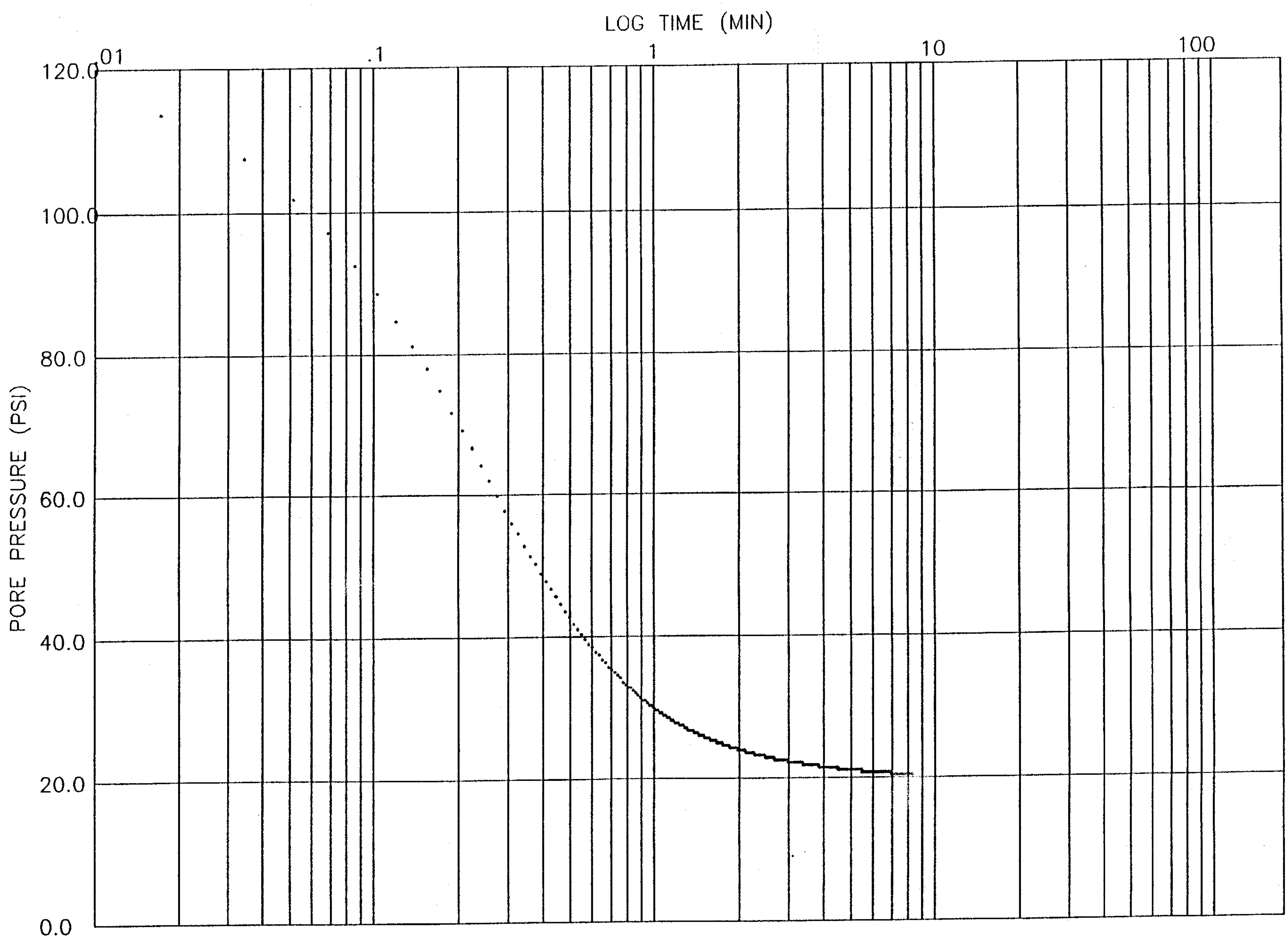

LOG TIME (MIN)
.01
.1
1
10
100
300.0
250.0
200.0
150.0
100.0
50.0
0.0
PORE PRESSURE (PSI)
CPT NUMBER: U1P052
JOB NUMBER: 95-5052
DISSIPATION TEST
DEPTH: 85.1 FEET
DATE: 05-04-1995



CPT NUMBER: U1P057
JOB NUMBER: 95-5052

DISSIPATION TEST

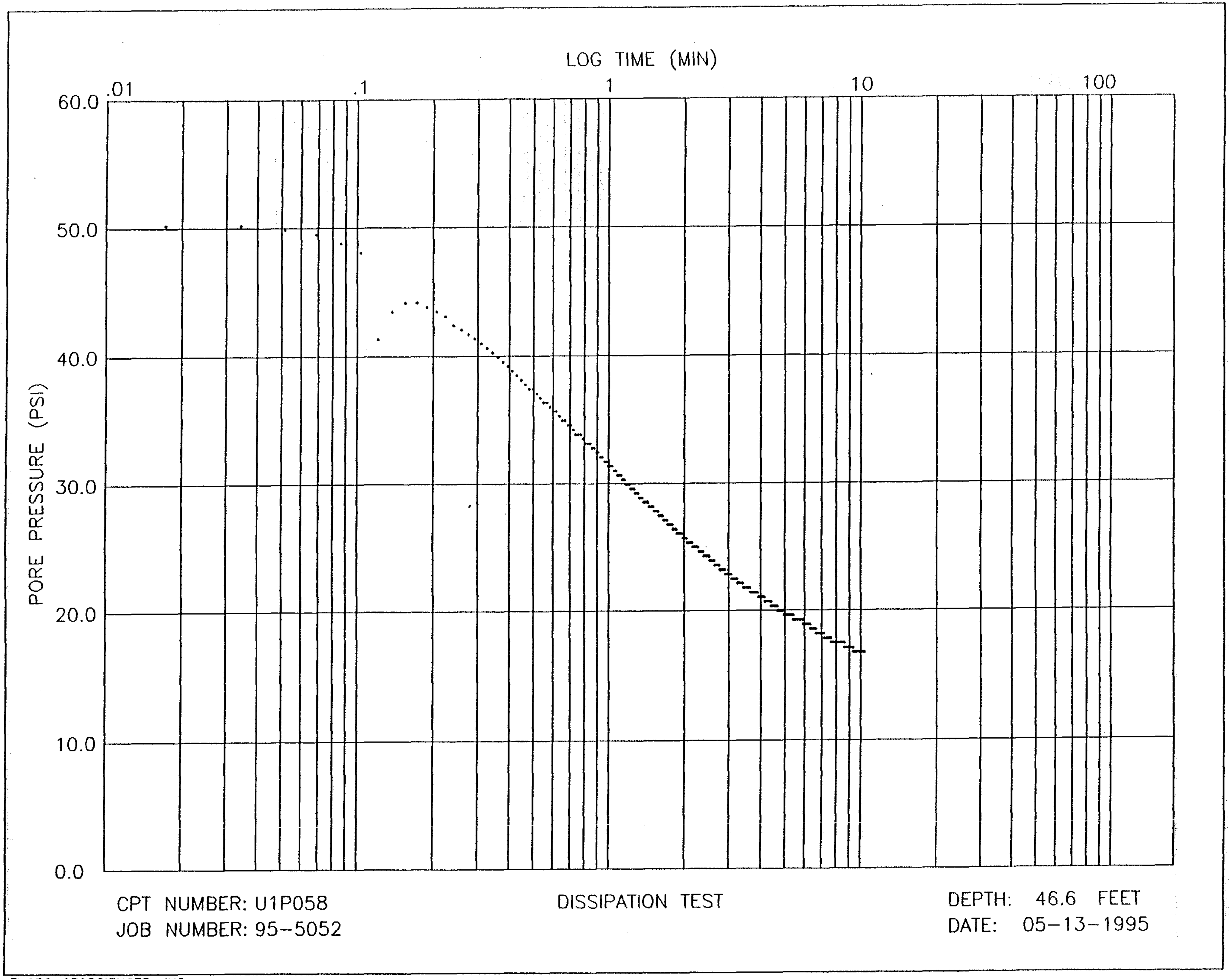
DEPTH: 59.4 FEET
DATE: 05-12-1995



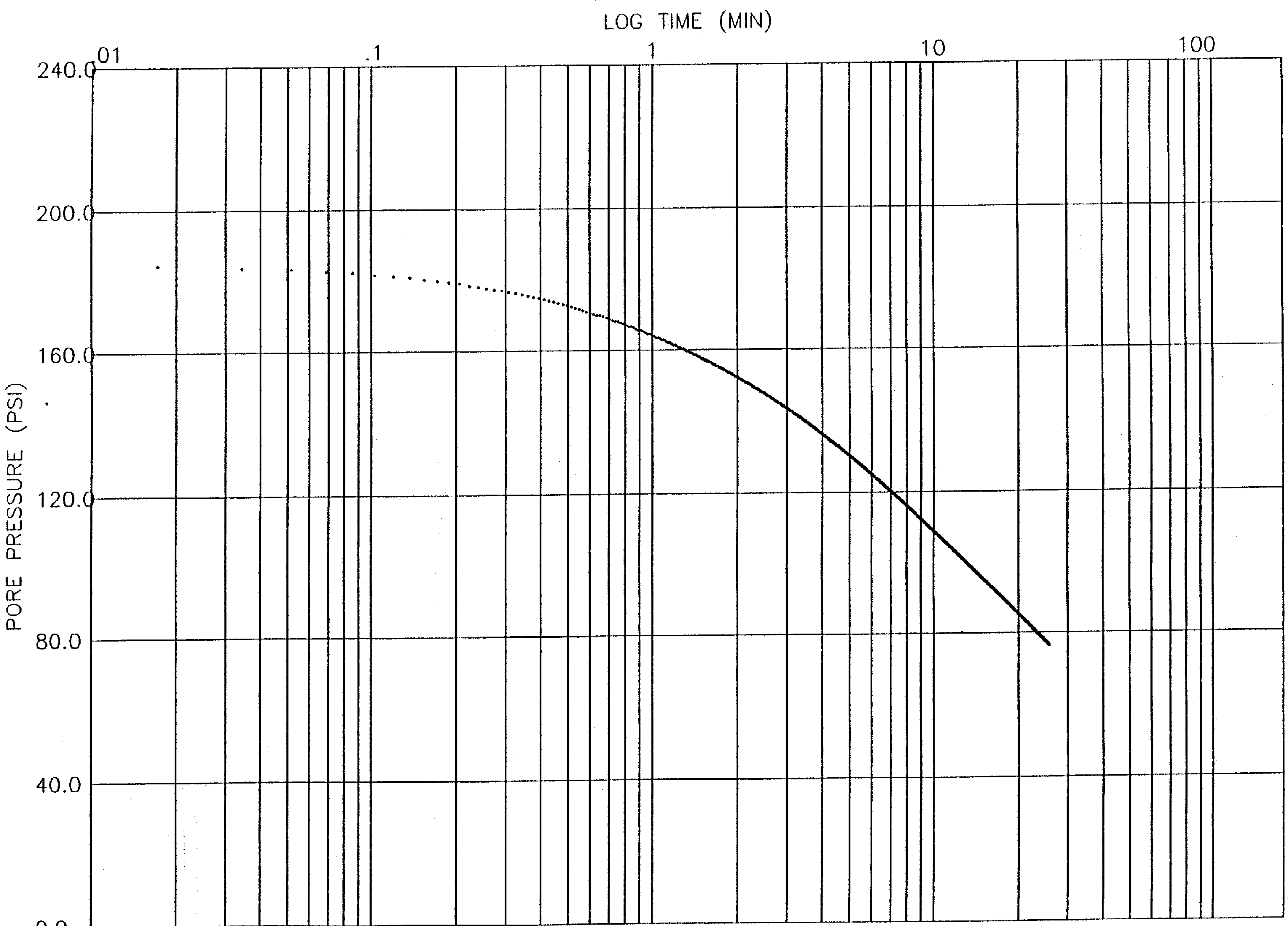
CPT NUMBER: U1P057
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 69.1 FEET
DATE: 05-12-1995



FUGRO GEOSCIENCES, INC.

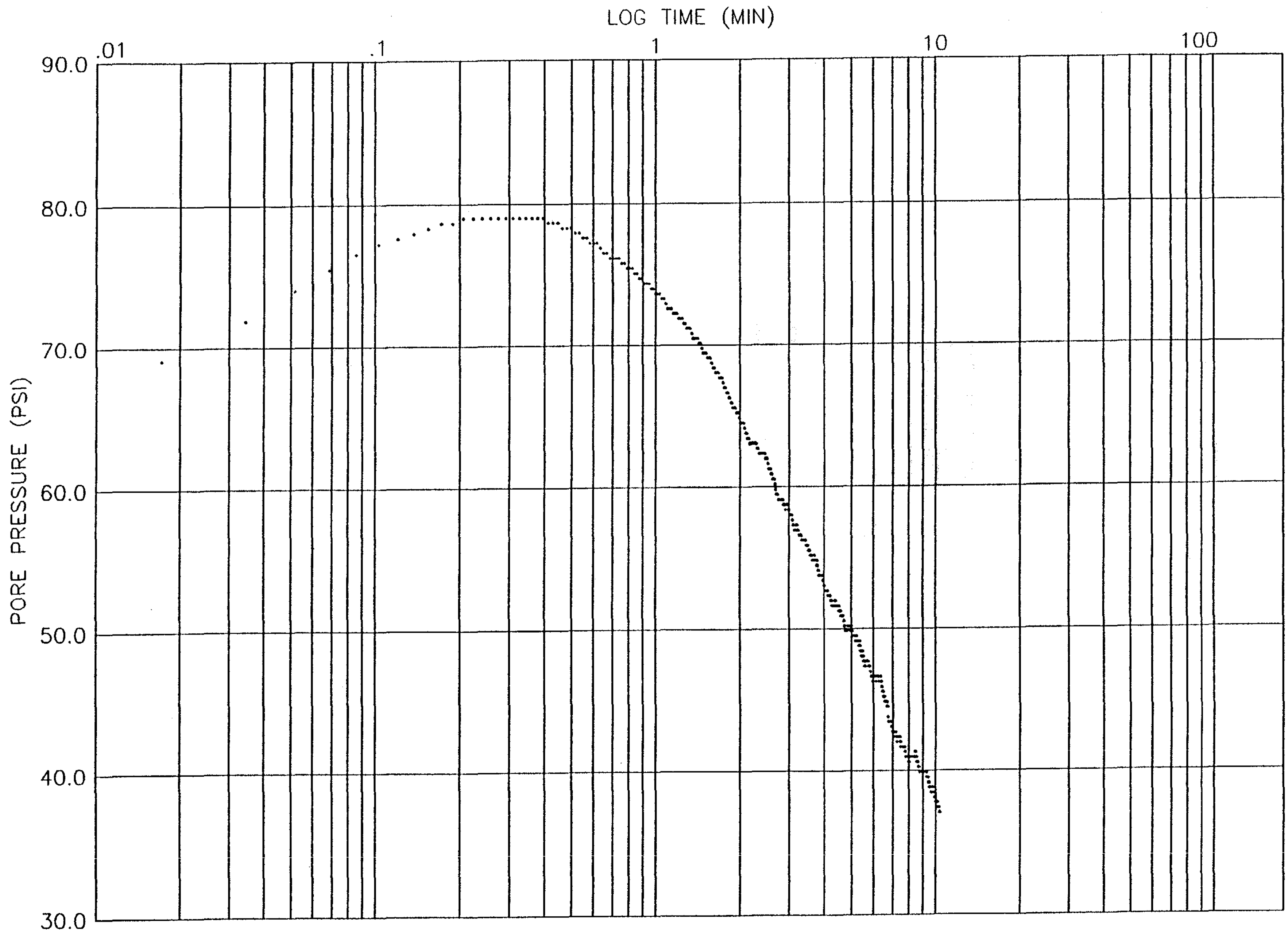


CPT NUMBER: U1P058
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 56.5 FEET
DATE: 05-13-1995

FUGRO GE... IENCES, INC.

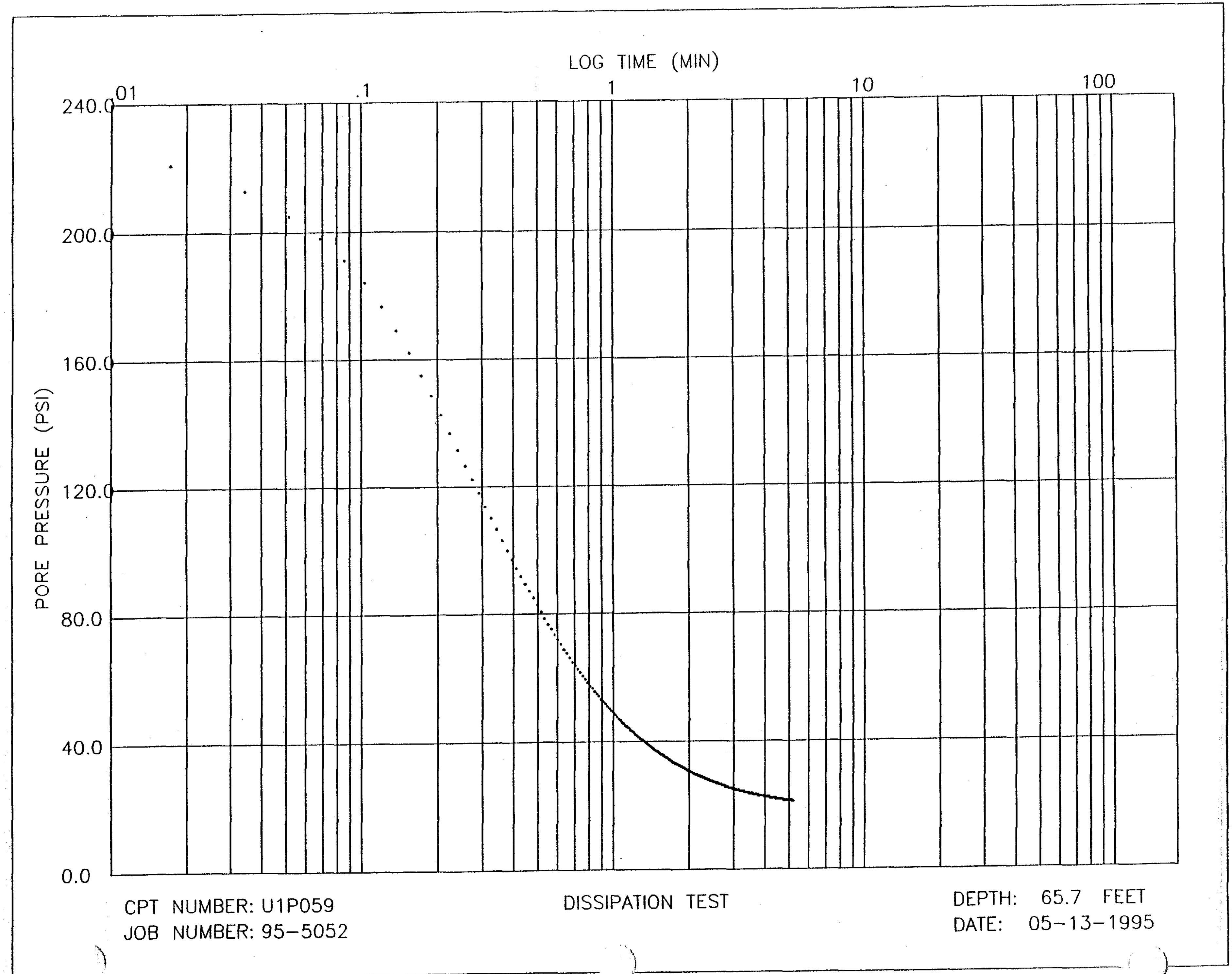


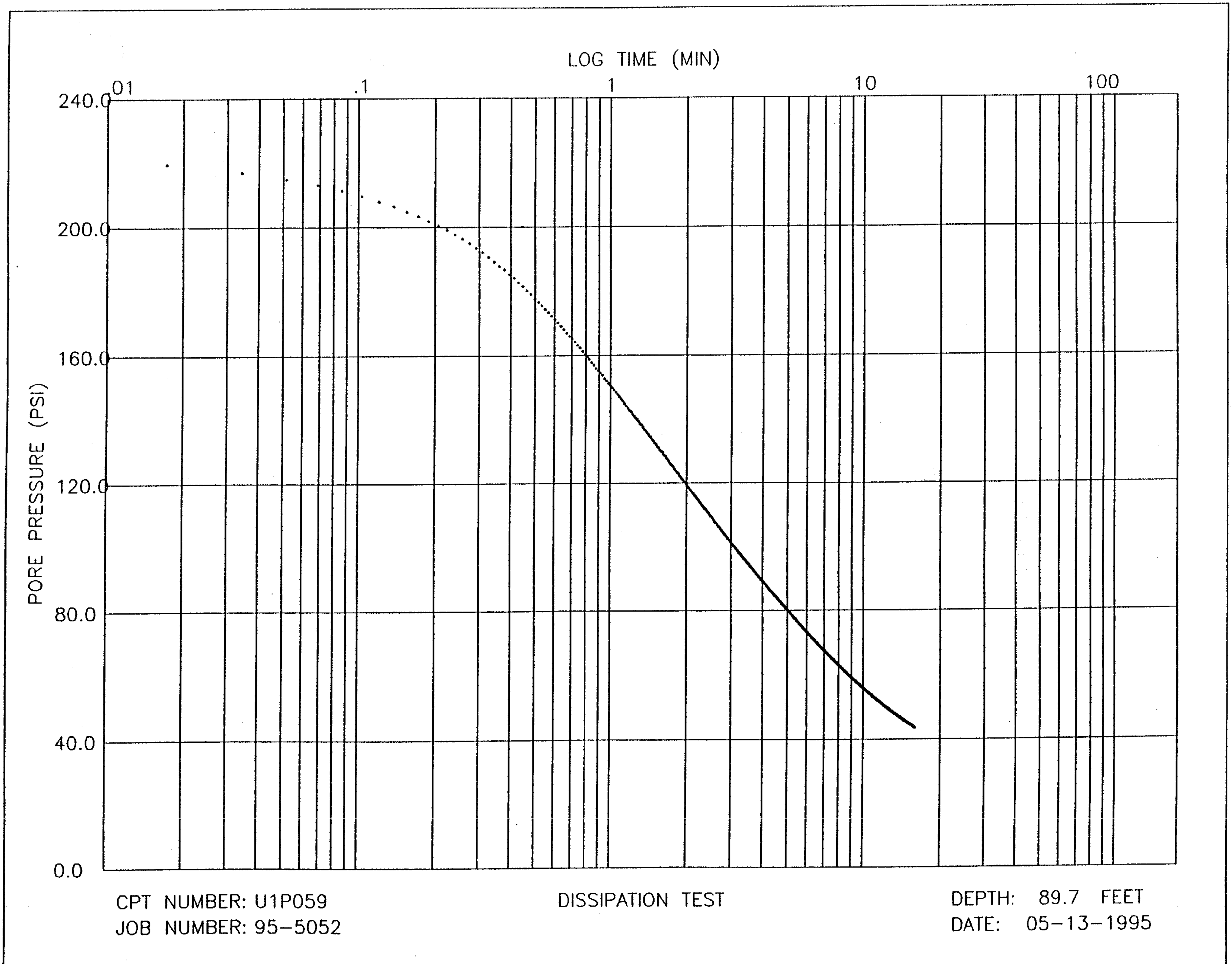
CPT NUMBER: U1P059
JOB NUMBER: 95-5052

DISSIPATION TEST

DEPTH: 58.3 FEET
DATE: 05-13-1995

FUGRO GEOSCIENCES, INC.


LOG TIME (MIN)
.01
.1
1
10
100
240.0
200.0
160.0
120.0
80.0
40.0
0.0
PORE PRESSURE (PSI)
CPT NUMBER: U1P059
JOB NUMBER: 95-5052
DISSIPATION TEST
DEPTH: 65.7 FEET
DATE: 05-13-1995



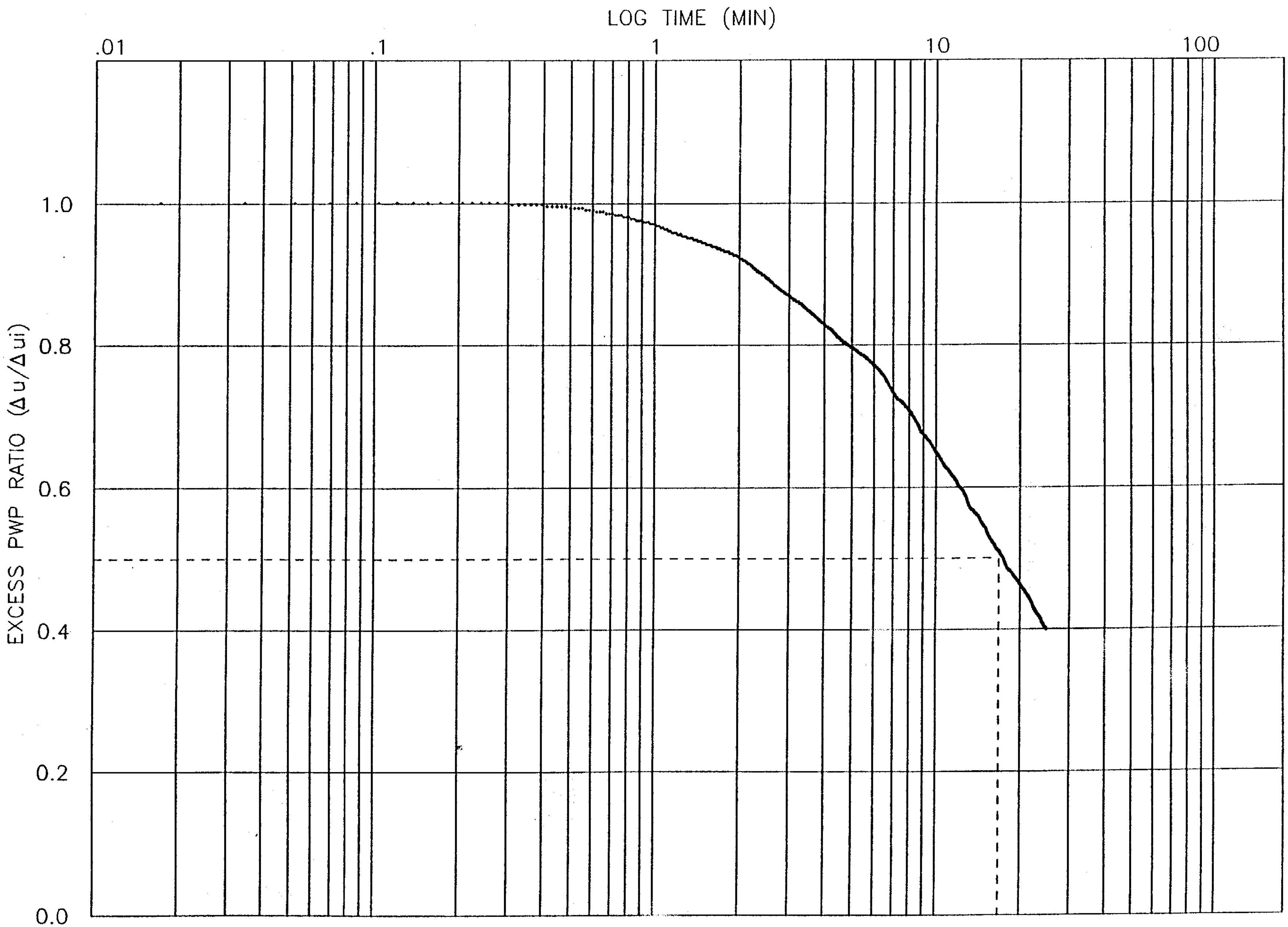
FUGRO GEOSCIENCES, INC.

PERMEABILITY

95-5052

CPT No.	Depth	Maximum Pressure (tsf)	Water Depth (ft)	Hydrostatic Pressure (tsf)	t_{50}	$T_{50}r^2$	C_h $T_{50}\,r^2/t_{50}$	Minimum Const. Modulus (C_m)	Maximum Const. Modulus (C_m)	Q_c	$1/C_{minimum} \cdot Q_c$	$1/C_{maximum} \cdot Q_c$	Unit Weight Water	k(min)	k(max)
U1P009	58.7	11.21	27	0.989	1004.4	16.695	0.016621864	3.5	7.5	24.58	0.012	0.005	0.001	1.93E-07	9.02E-08
U1P009	79.4	8.32	27	1.635	2.46	16.695	6.786585366	3	11	88.07	0.004	0.001	0.001	2.57E-05	7.01E-06
U1P019	70.6	14.51	24	1.454	10.2	16.695	1.636764706	3.5	7.5	18.43	0.016	0.007	0.001	2.54E-05	1.18E-05
U1P021	14.8	16.18	7.5	0.228	14.4	16.695	1.159375	3	11	156.17	0.002	0.001	0.001	2.47E-06	6.75E-07
U1P033	40.3	0.92	21	0.602	14.4	16.695	1.159375	3	11	82.44	0.004	0.001	0.001	4.69E-06	1.28E-06
U1P033	58.6	8.24	21	1.173	18.6	16.695	0.897580645	3.5	7.5	15.36	0.019	0.009	0.001	1.67E-05	7.79E-06
U1P039	50.2	0.77	16	1.067	317.4	16.695	0.052599244	3	11	181.26	0.002	0.001	0.001	9.67E-08	2.64E-08
U1P039	60.4	5.48	16	1.385	320.4	16.695	0.052106742	2.5	6.3	9.73	0.041	0.016	0.001	2.14E-06	8.50E-07
U1P039	61.5	6.48	16	1.420	168.6	16.695	0.099021352	2.5	6.3	9.22	0.043	0.017	0.001	4.30E-06	1.70E-06
U1P048	50.2	7.63	20	0.942	325.8	16.695	0.051243094	2.5	6.3	15.87	0.025	0.010	0.001	1.29E-06	5.13E-07
U1P048	59.5	14.18	20	1.232	455.4	16.695	0.036660079	3.5	7.5	15.36	0.019	0.009	0.001	6.82E-07	3.18E-07
U1P048	79.9	9.39	20	1.869	8.4	16.695	1.9875	3.5	7.5	68.61	0.004	0.002	0.001	8.28E-06	3.86E-06
U1P048	81.1	20.05	20	1.906	82.2	16.695	0.20310219	3.5	7.5	24.07	0.012	0.006	0.001	2.41E-06	1.13E-06
U1P050	69.4	8.19	20	1.541	74.4	16.695	0.224395161	2.5	6.3	16.38	0.024	0.010	0.001	5.48E-06	2.17E-06
U1P050	82.4	7.86	20	1.947	21.6	16.695	0.772916667	3.5	7.5	43.52	0.007	0.003	0.001	5.07E-06	2.37E-06
U1P052	65.2	2.36	21	1.379	99.6	16.695	0.167620482	3.5	7.5	6.66	0.043	0.020	0.001	7.19E-06	3.36E-06
U1P052	72.8	4.97	21	1.616	5.4	16.695	3.091666667	3	11	20.99	0.016	0.004	0.001	4.91E-05	1.34E-05
U1P052	85.1	19.61	21	2.000	99.6	16.695	0.167620482	3.5	7.5	35.84	0.008	0.004	0.001	1.34E-06	6.24E-07
*U1P057	59.4	4.94	21.5	1.182	1140	16.695	0.014644737	2.5	7.5	6.66	0.060	0.020	0.001	8.80E-07	2.93E-07
U1P057	69.1	8.17	21.5	1.485	12.6	16.695	1.325	3.5	7.5	14.85	0.019	0.009	0.001	2.55E-05	1.19E-05
U1P058	46.6	3.17	18	0.892	75.6	16.695	0.220833333	3.5	7.5	11.26	0.025	0.012	0.001	5.60E-06	2.61E-06
U1P058	56.5	13.26	18	1.201	741.6	16.695	0.022512136	2.5	6.3	14.85	0.027	0.011	0.001	6.06E-07	2.41E-07
U1P059	58.3	5.68	20	1.195	311.4	16.695	0.053612717	2.5	6.3	13.82	0.029	0.011	0.001	1.55E-06	6.16E-07
U1P059	65.7	15.89	20	1.426	16.2	16.695	1.030555556	3.5	7.5	23.04	0.012	0.006	0.001	1.28E-05	5.96E-06
U1P059	89.7	15.79	20	2.175	20	16.695	0.83475	3.5	7.5	22.020	0.013	0.006	0.001	1.08E-05	5.05E-06

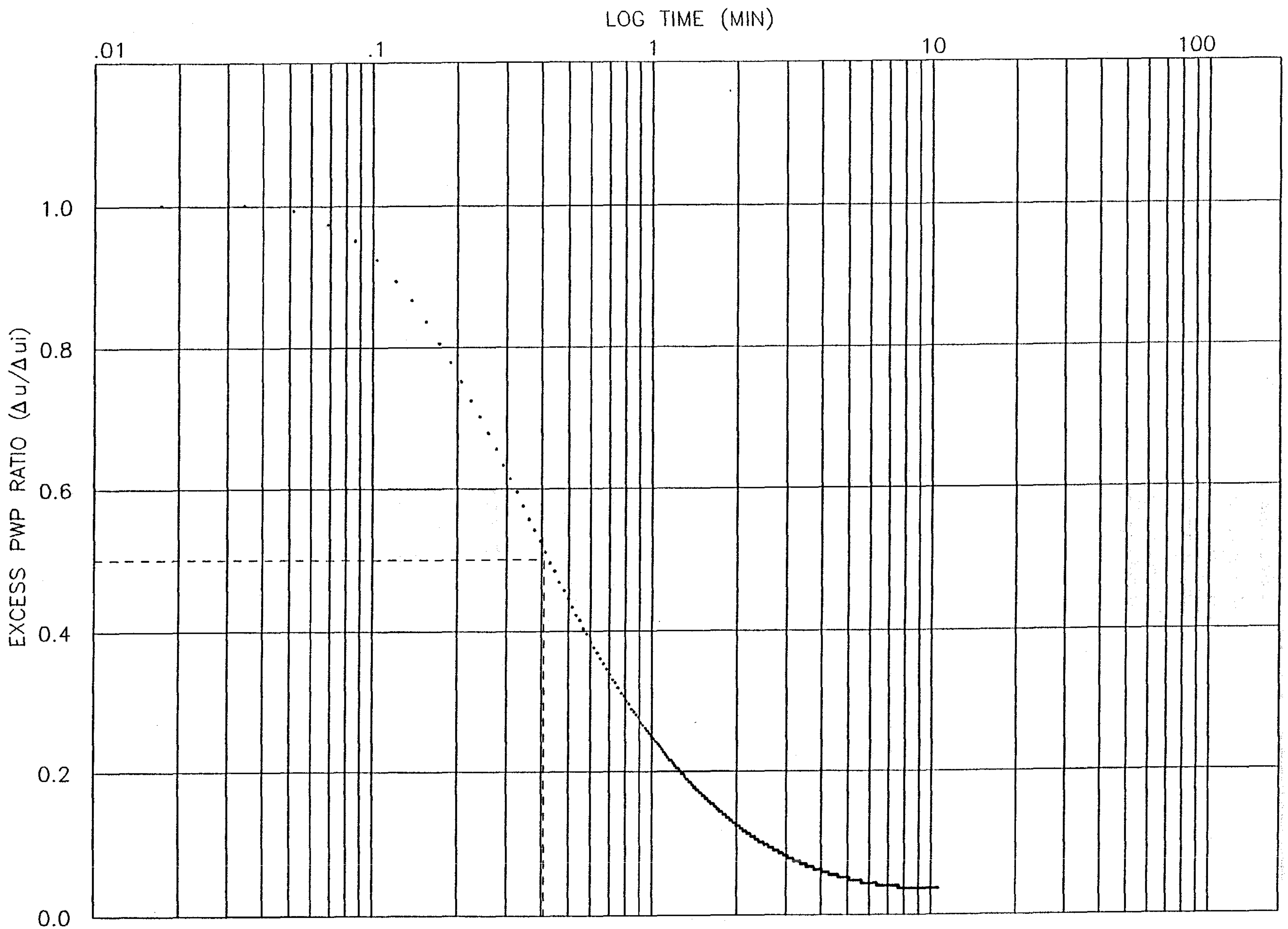
NOTES: * INTERPRETED t50



CPT NUMBER: U1P009
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 16.74

DEPTH: 58.7 FEET
DATE: 05-12-1995

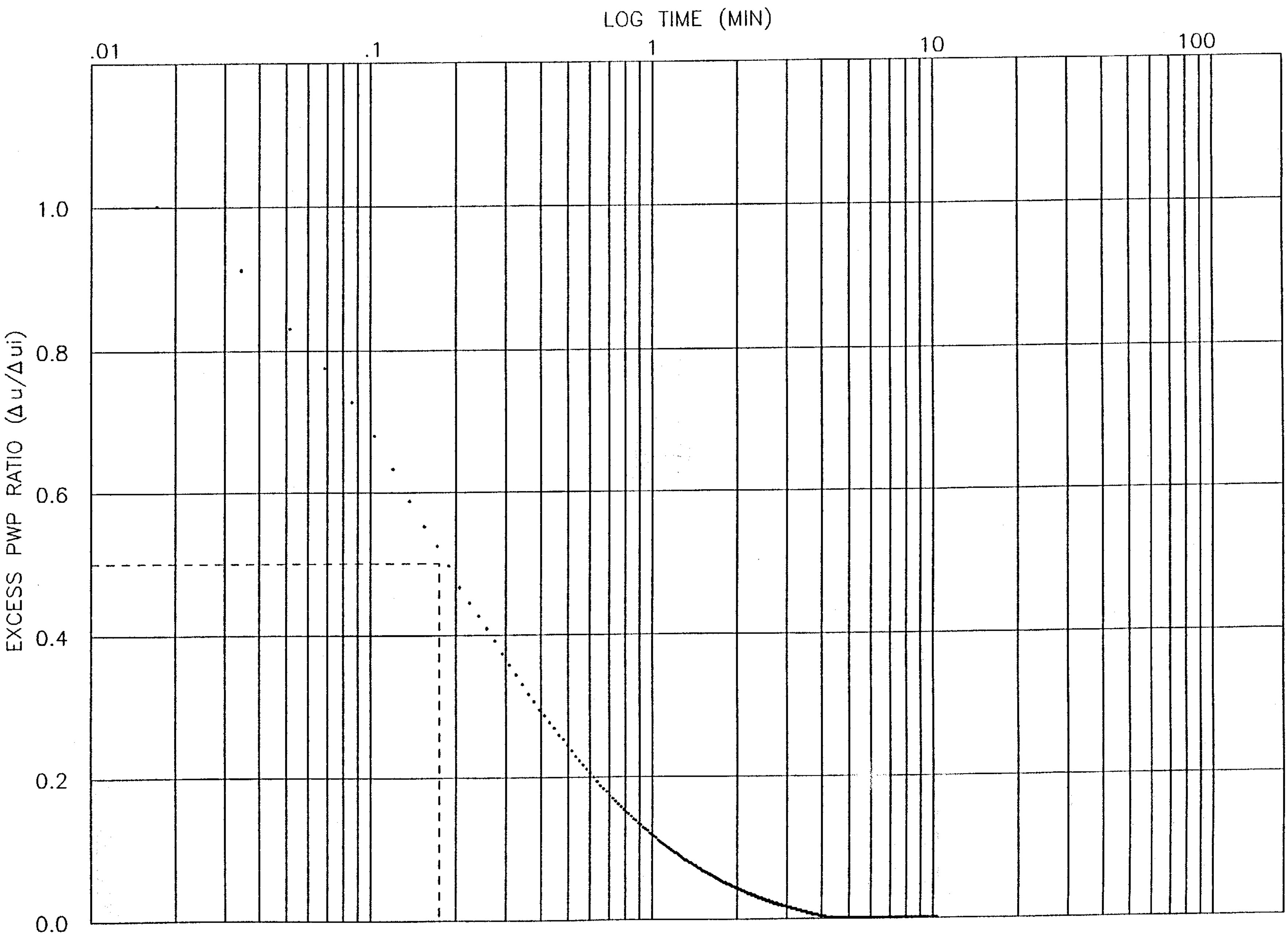


CPT NUMBER: U1P009
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 0.41

DEPTH: 79.4 FEET
DATE: 05-12-1995

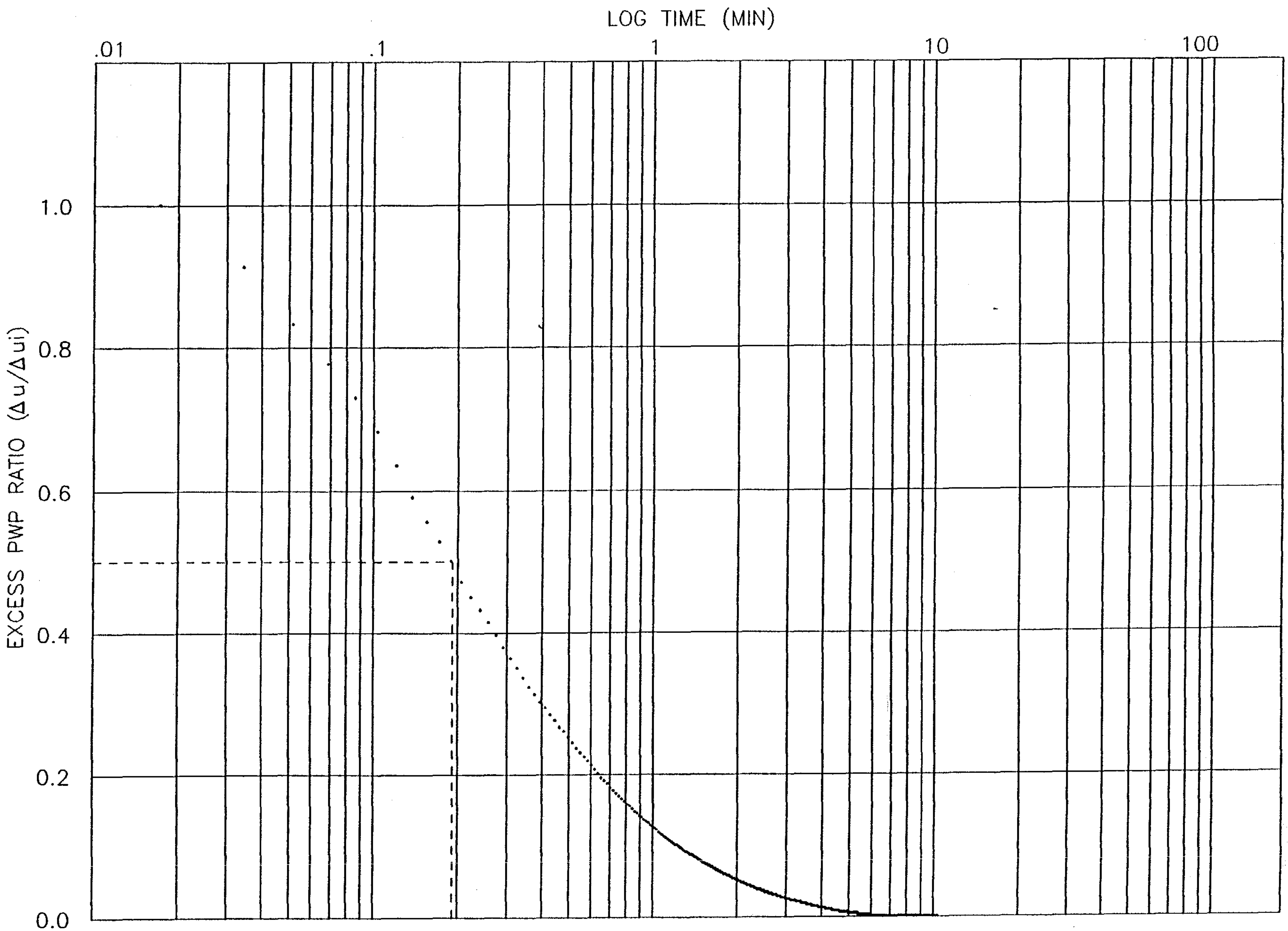
FUGRO GEOSCIENCES, INC.



CPT NUMBER: U1P019
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 0.17

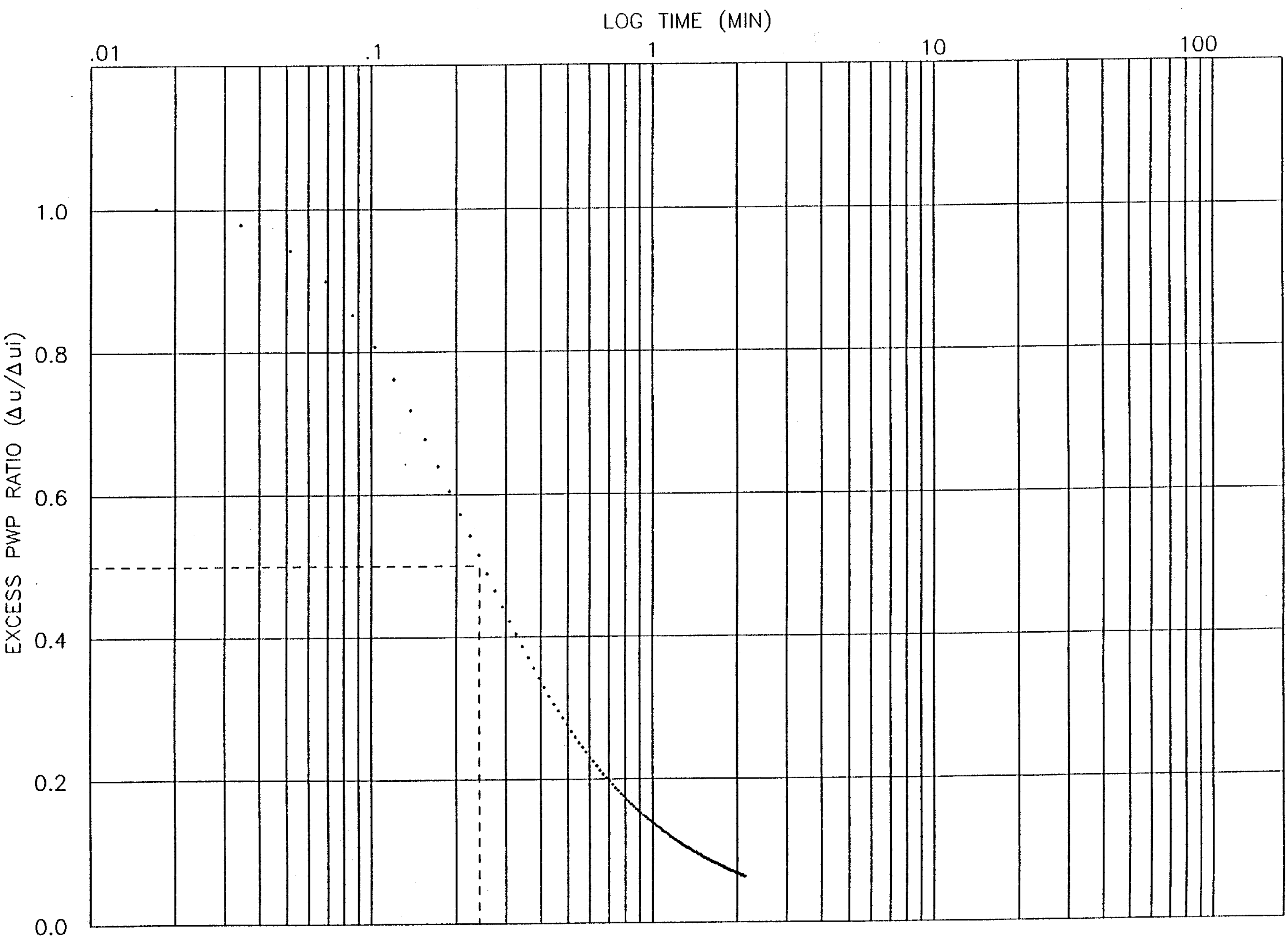
DEPTH: 70.6 FEET
DATE: 05-04-1995



CPT NUMBER: U1P019
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 0.19

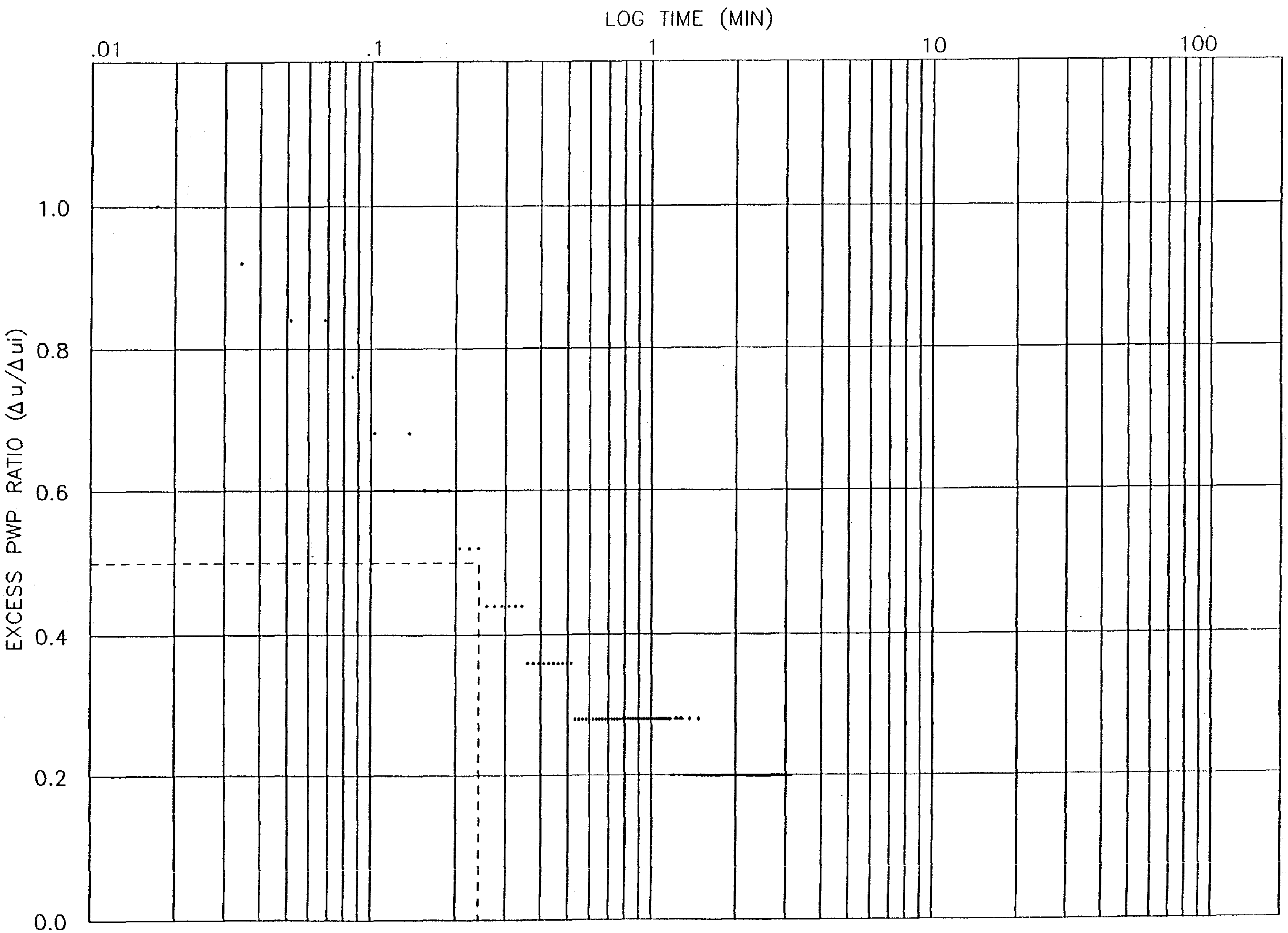
DEPTH: 70.6 FEET
DATE: 05-04-1995



CPT NUMBER: U1P021
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 0.24

DEPTH: 14.8 FEET
DATE: 05-03-1995

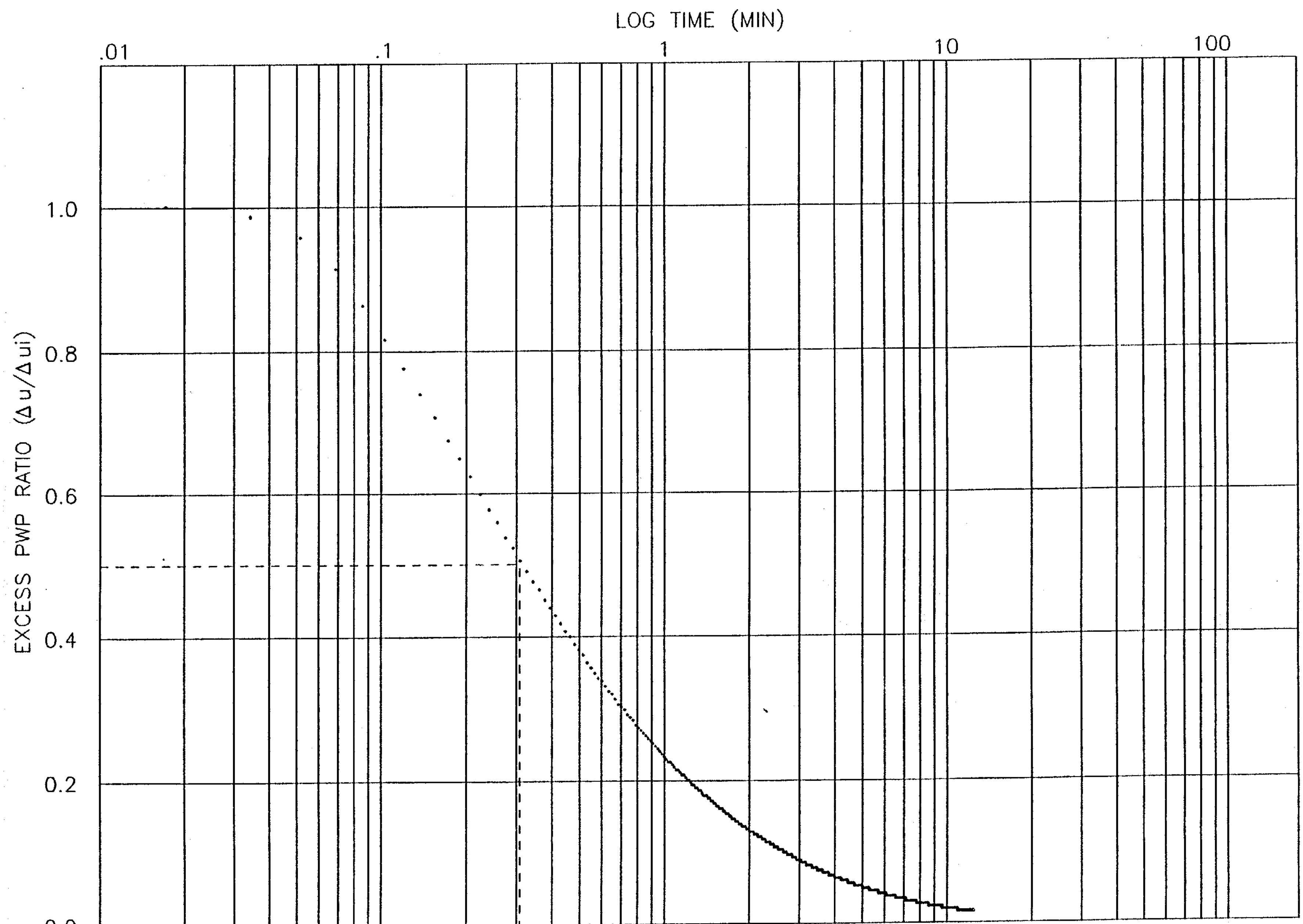


CPT NUMBER: U1P033
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 0.24

DEPTH: 40.3 FEET
DATE: 05-03-1995

FUGRO GEOSCIENCES, INC.

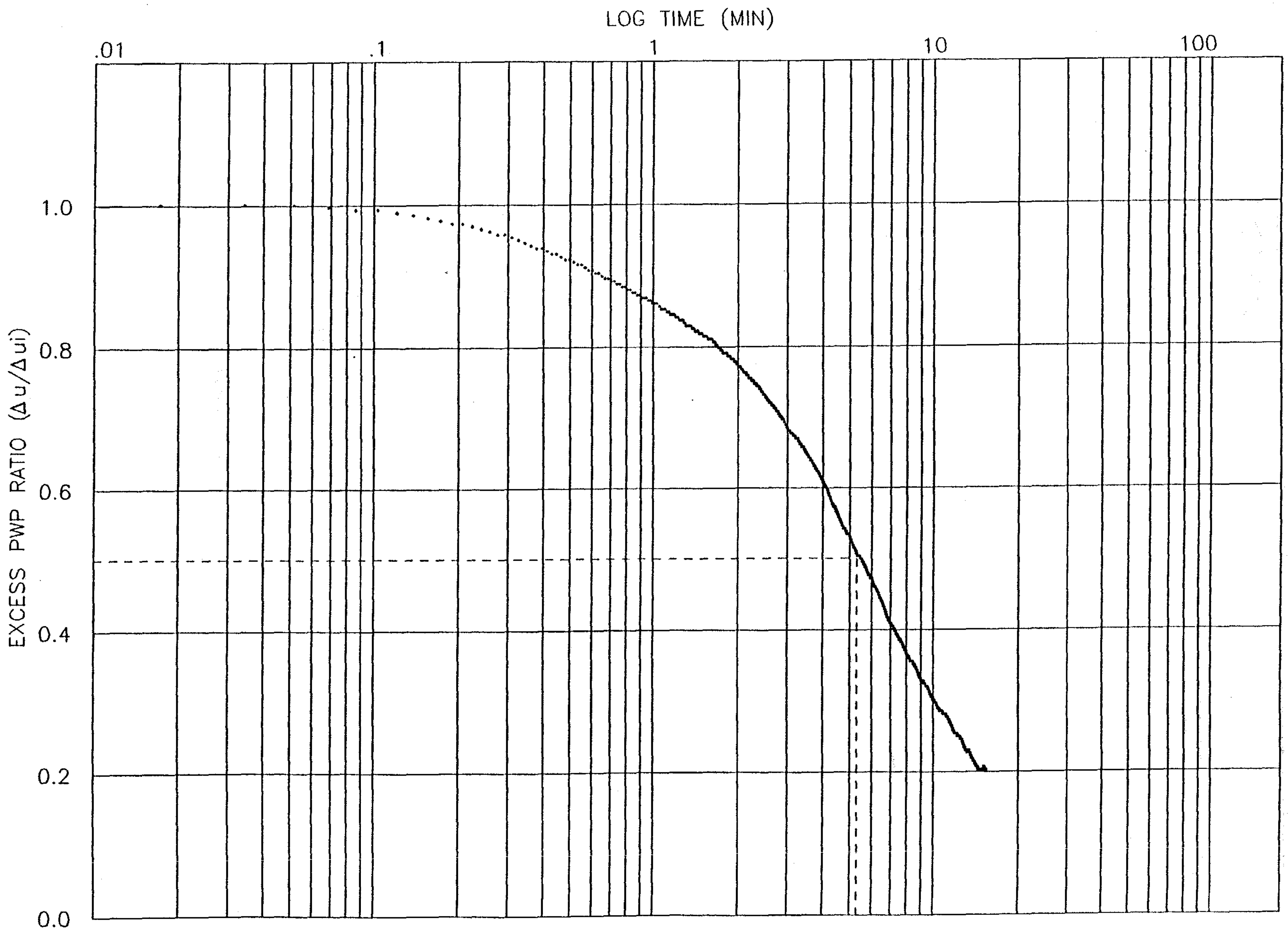


CPT NUMBER: U1P033
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 0.31

DEPTH: 58.6 FEET
DATE: 05-03-1995

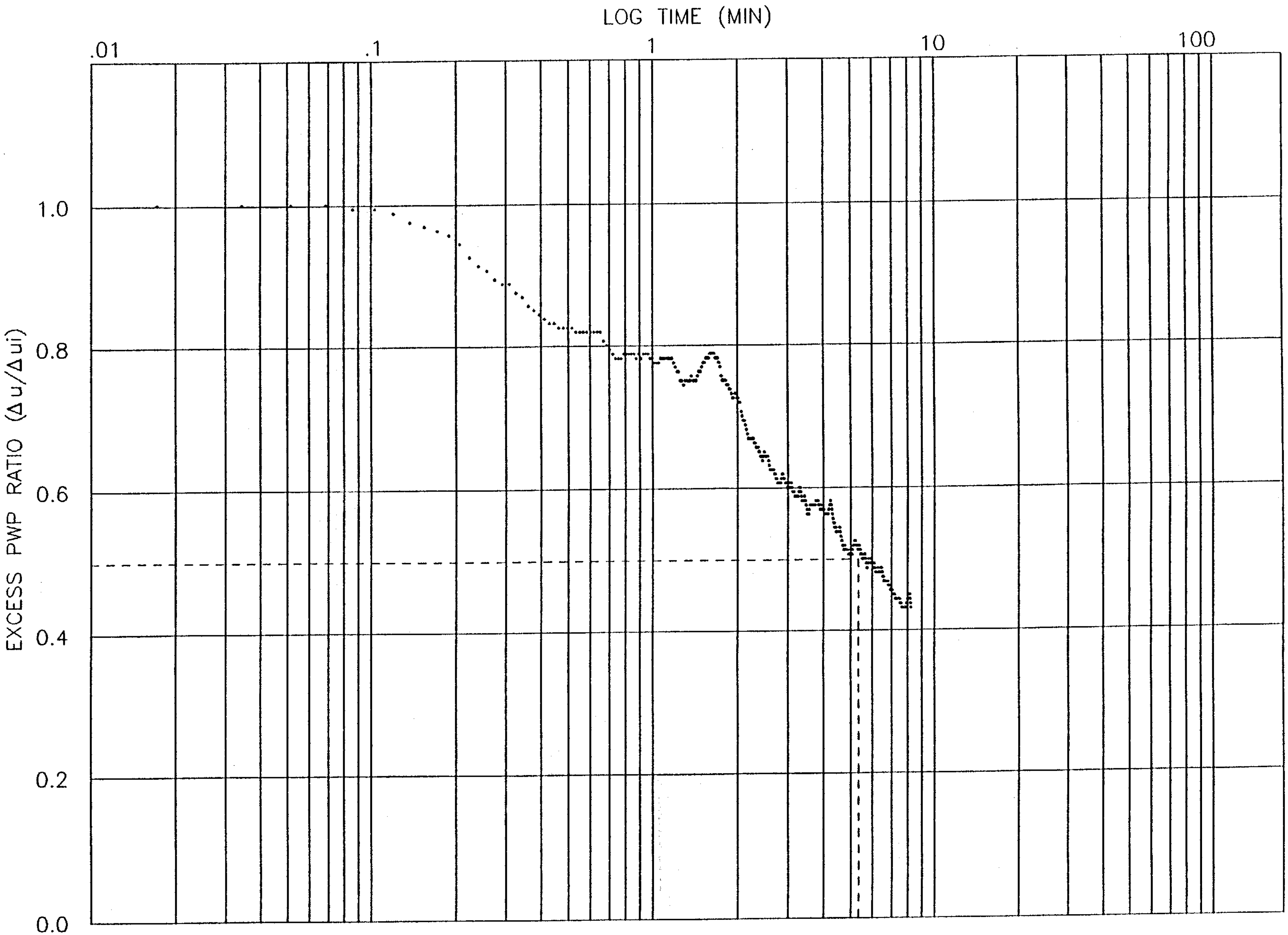
FUGRO GE[illegible]IENCES, INC.



CPT NUMBER: U1P048
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 5.29

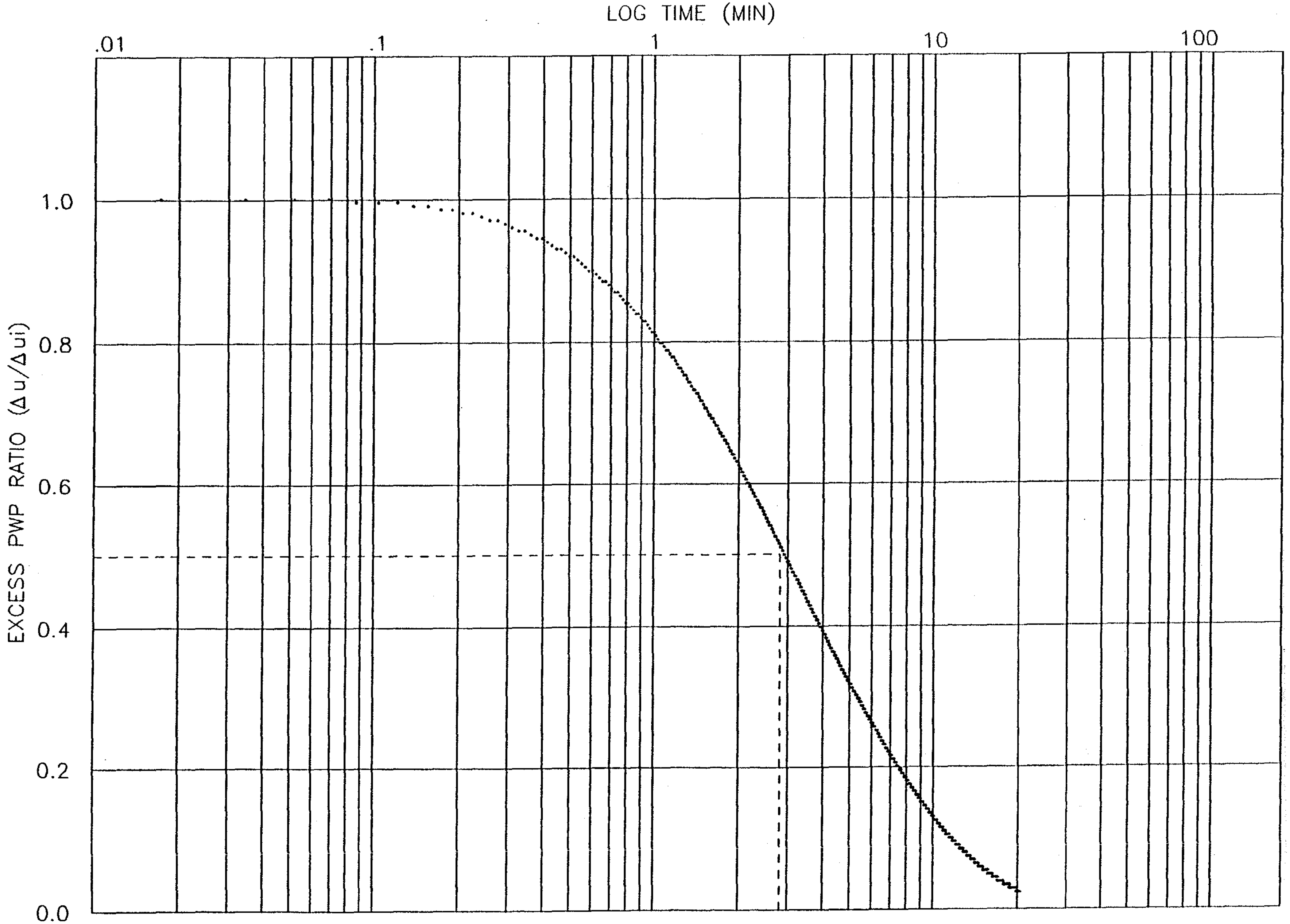
DEPTH: 50.2 FEET
DATE: 05-04-1995



CPT NUMBER: U1P039
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 5.34

DEPTH: 60.4 FEET
DATE: 05-04-1995

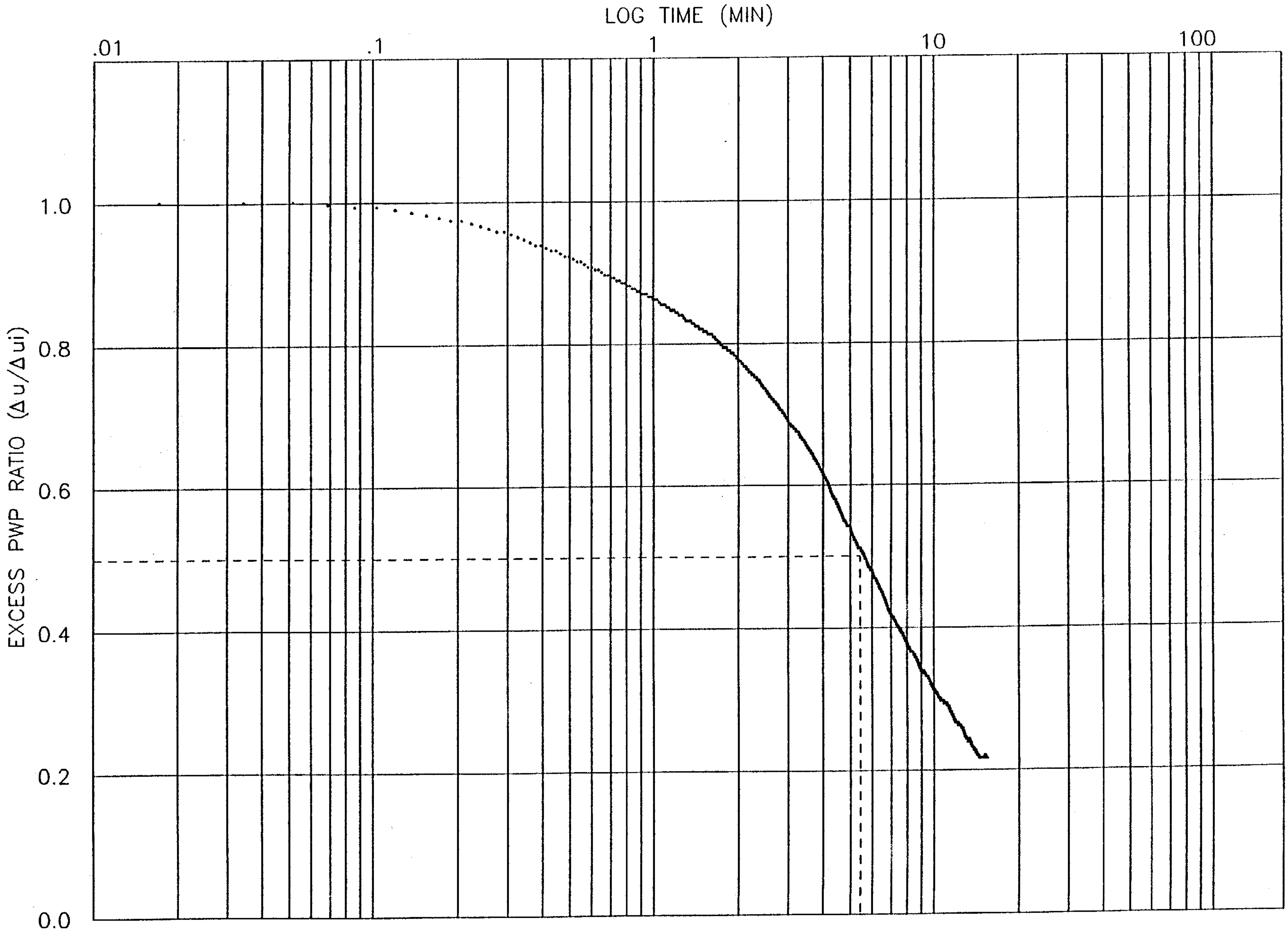


CPT NUMBER: U1P039
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 2.81

DEPTH: 61.5 FEET
DATE: 05-04-1995

FUGRO GEOSCIENCES, INC.

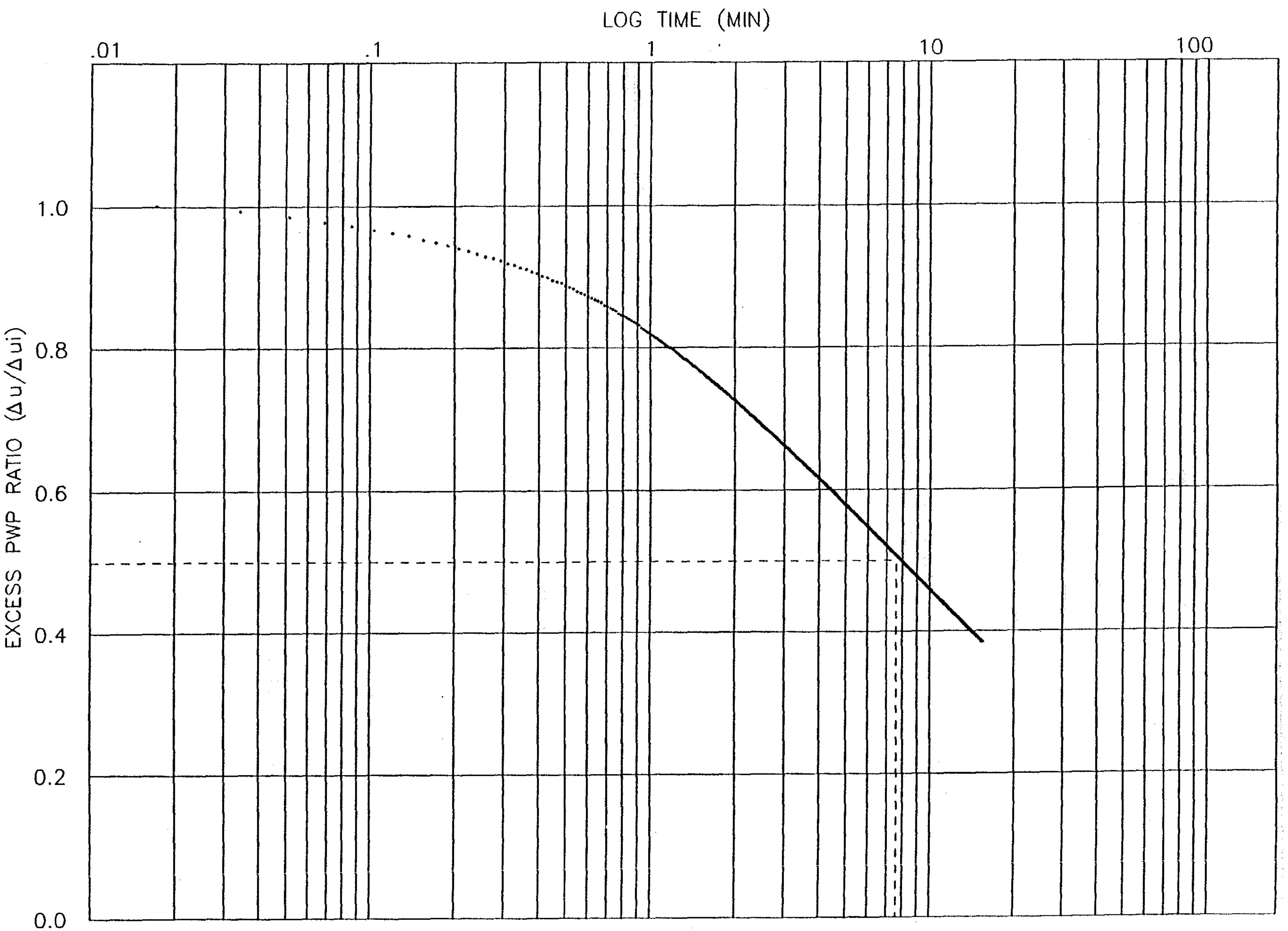


CPT NUMBER: U1P048
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 5.43

DEPTH: 50.2 FEET
DATE: 05-04-1995

FUGRO G... CIENCES, INC.

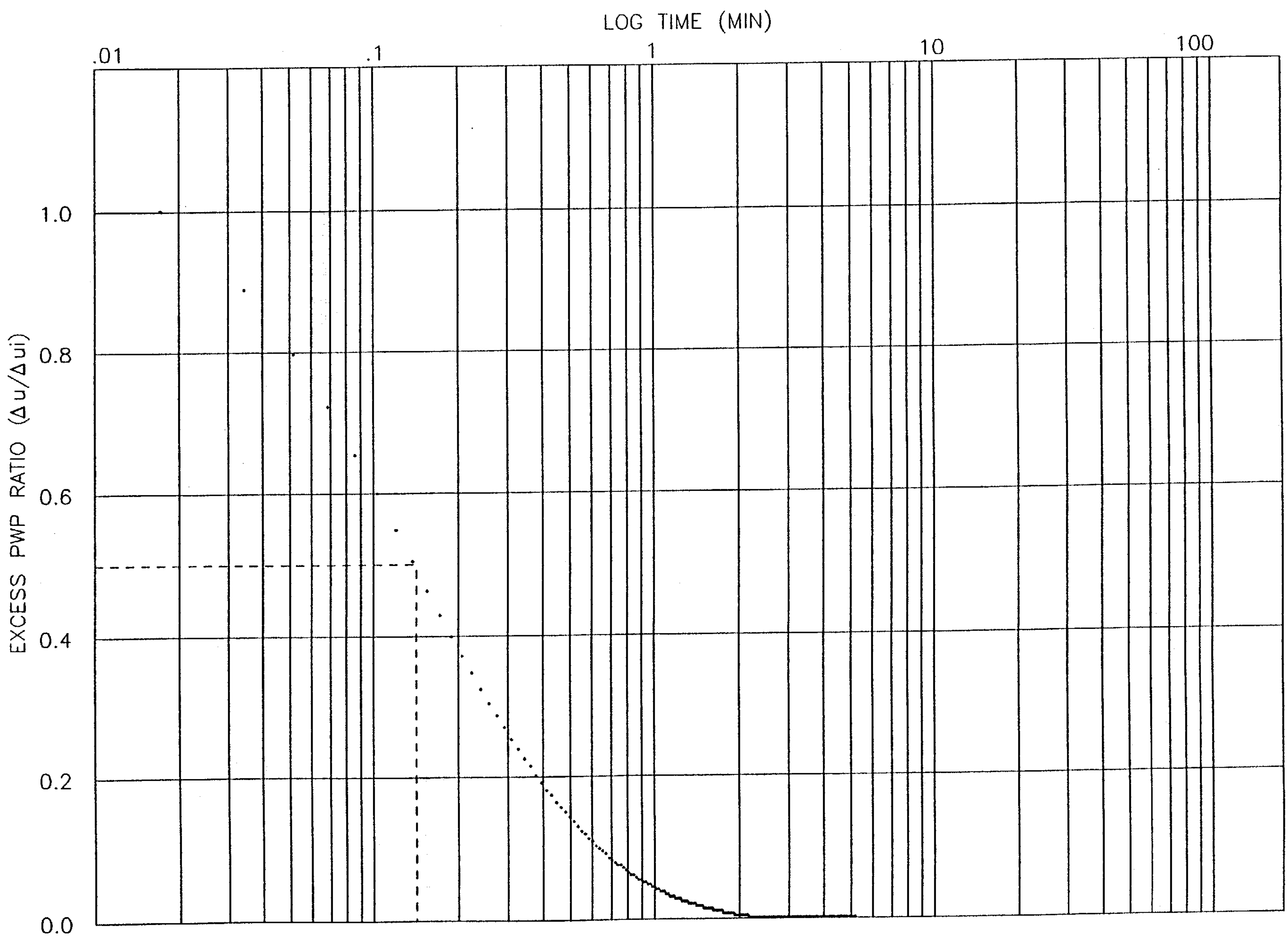


CPT NUMBER: U1P048
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 7.59

DEPTH: 59.5 FEET
DATE: 05-04-1995

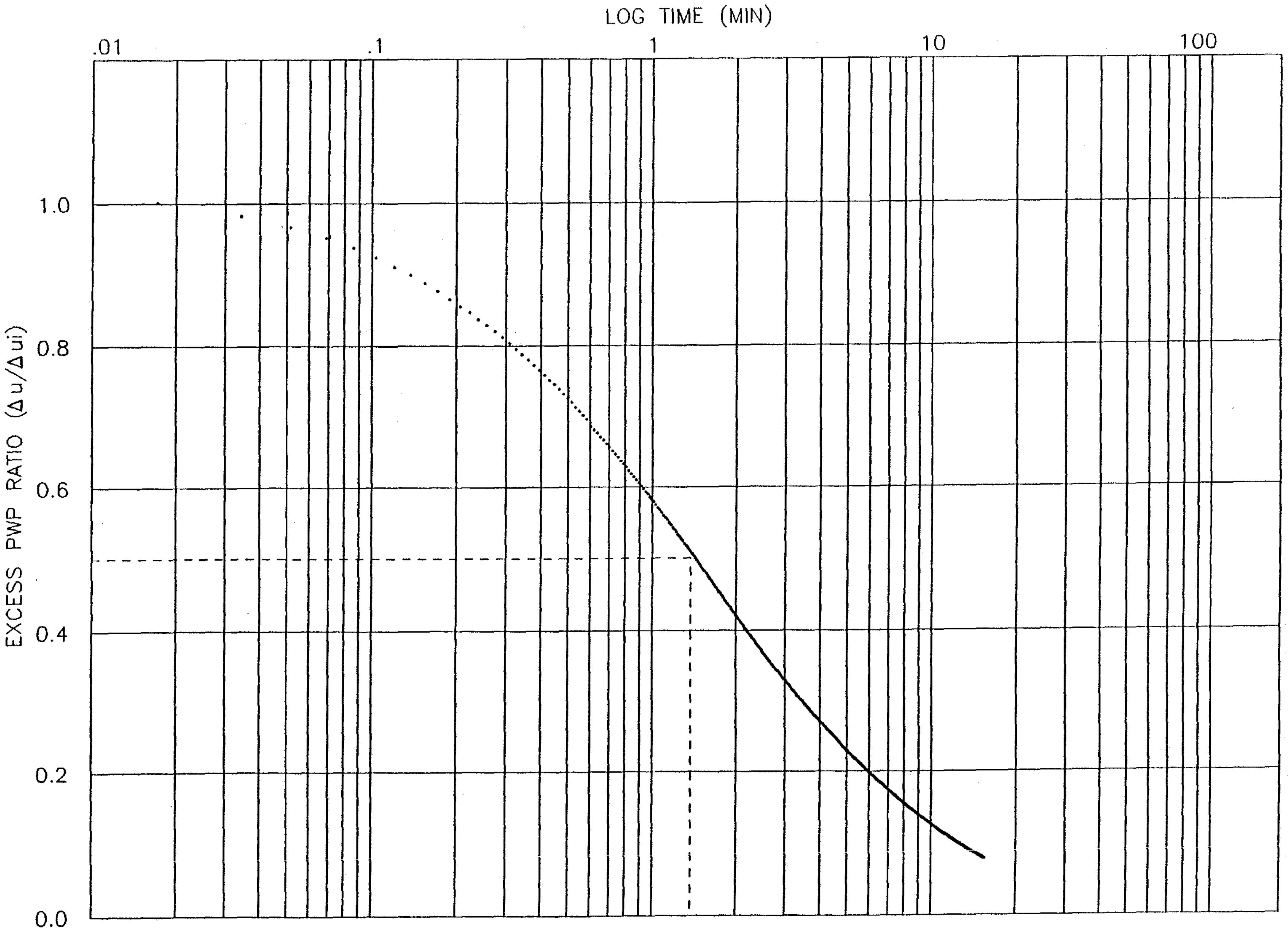
FUGRO GEOSCIENCES, INC.



CPT NUMBER: U1P048
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 0.14

DEPTH: 79.9 FEET
DATE: 05-04-1995

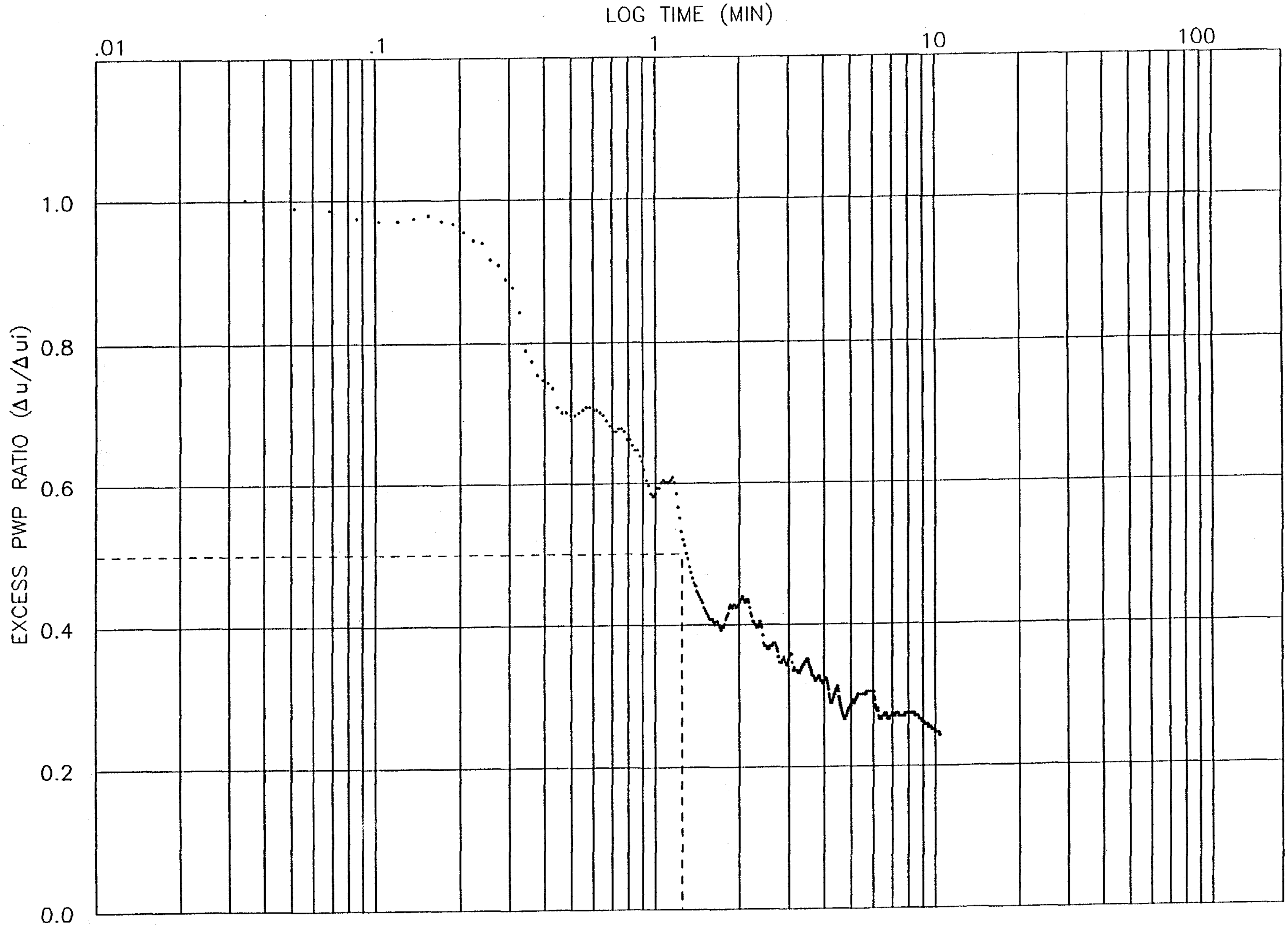


CPT NUMBER: U1P048
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 1.37

DEPTH: 81.1 FEET
DATE: 05-04-1995

FUGRO GEOSCIENCES, INC.

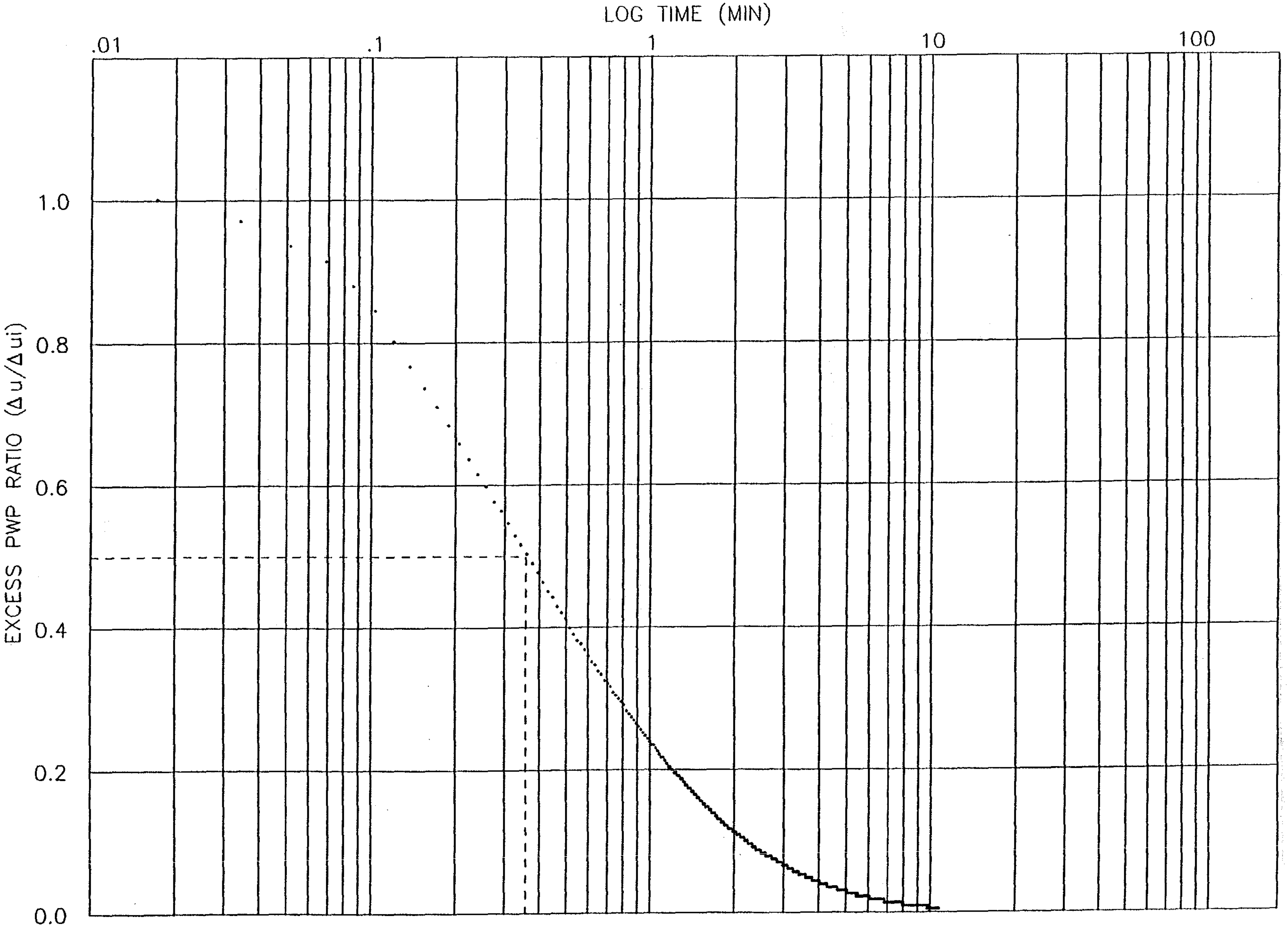


CPT NUMBER: U1P050
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 1.24

DEPTH: 69.4 FEET
DATE: 05-05-1995

FUGRO G... SCIENCES, INC.

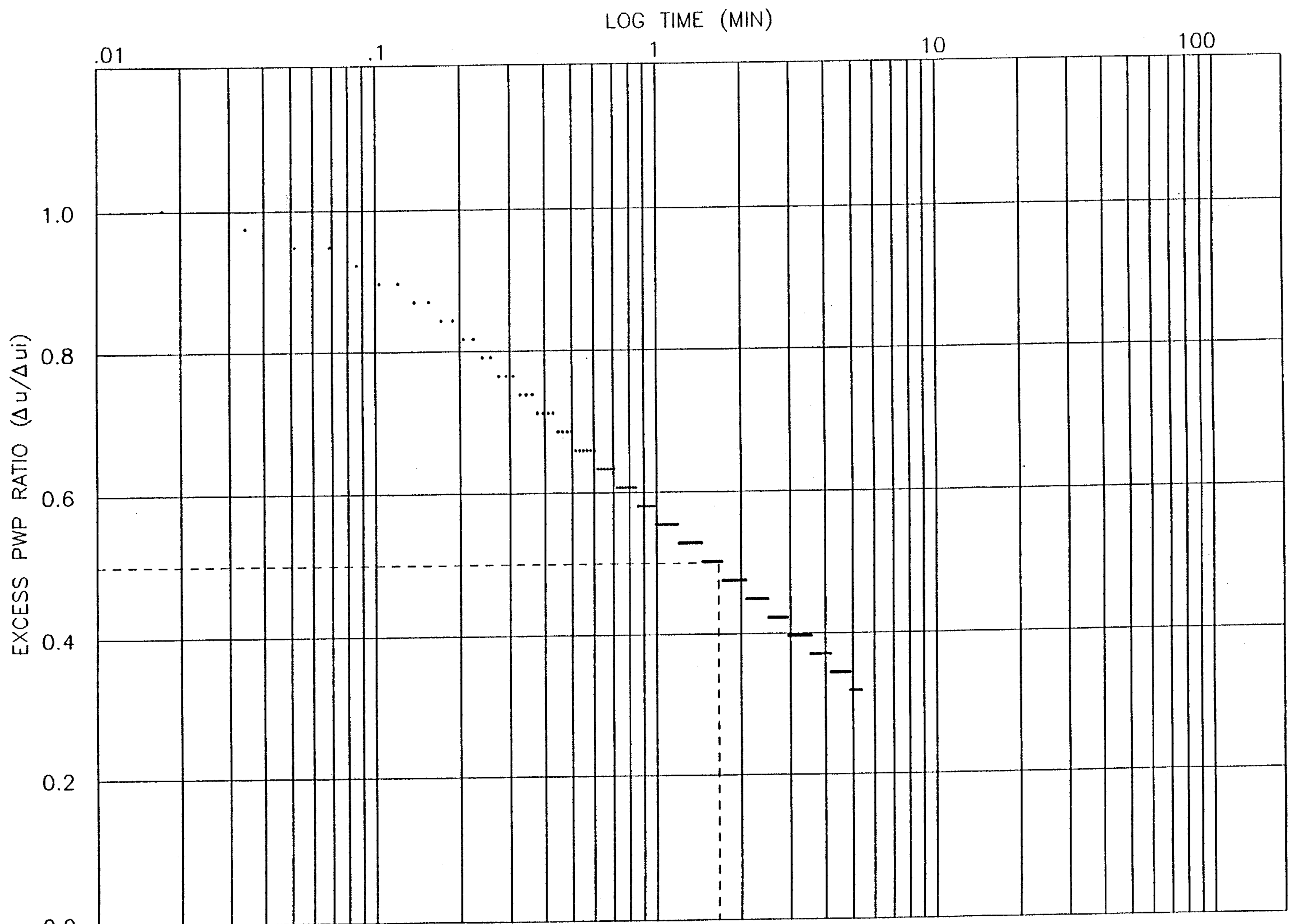


CPT NUMBER: U1P050
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 0.36

DEPTH: 82.4 FEET
DATE: 05-05-1995

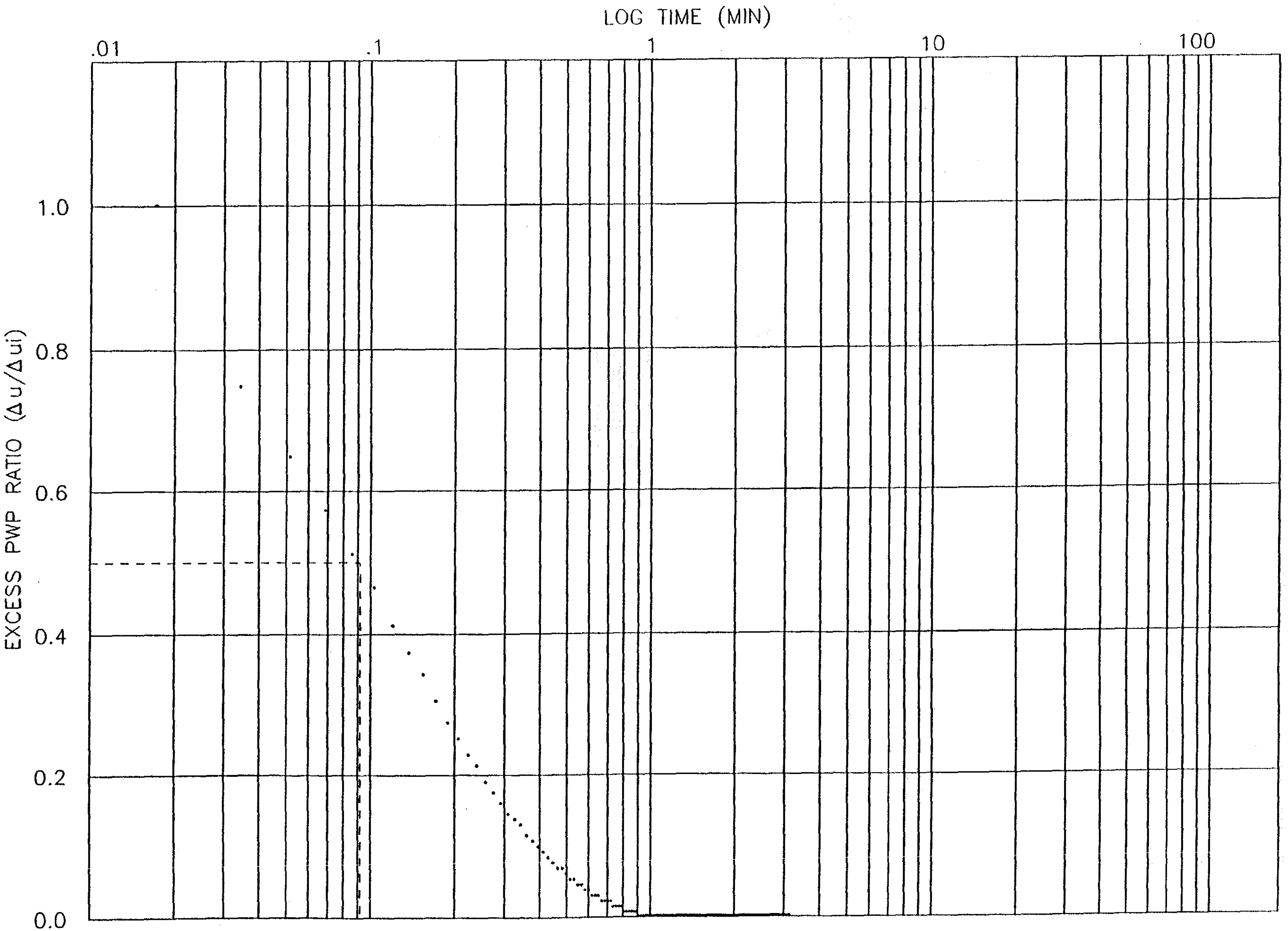
FUGRO GEOSCIENCES, INC.



CPT NUMBER: U1P052
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 1.66

DEPTH: 65.2 FEET
DATE: 05-04-1995

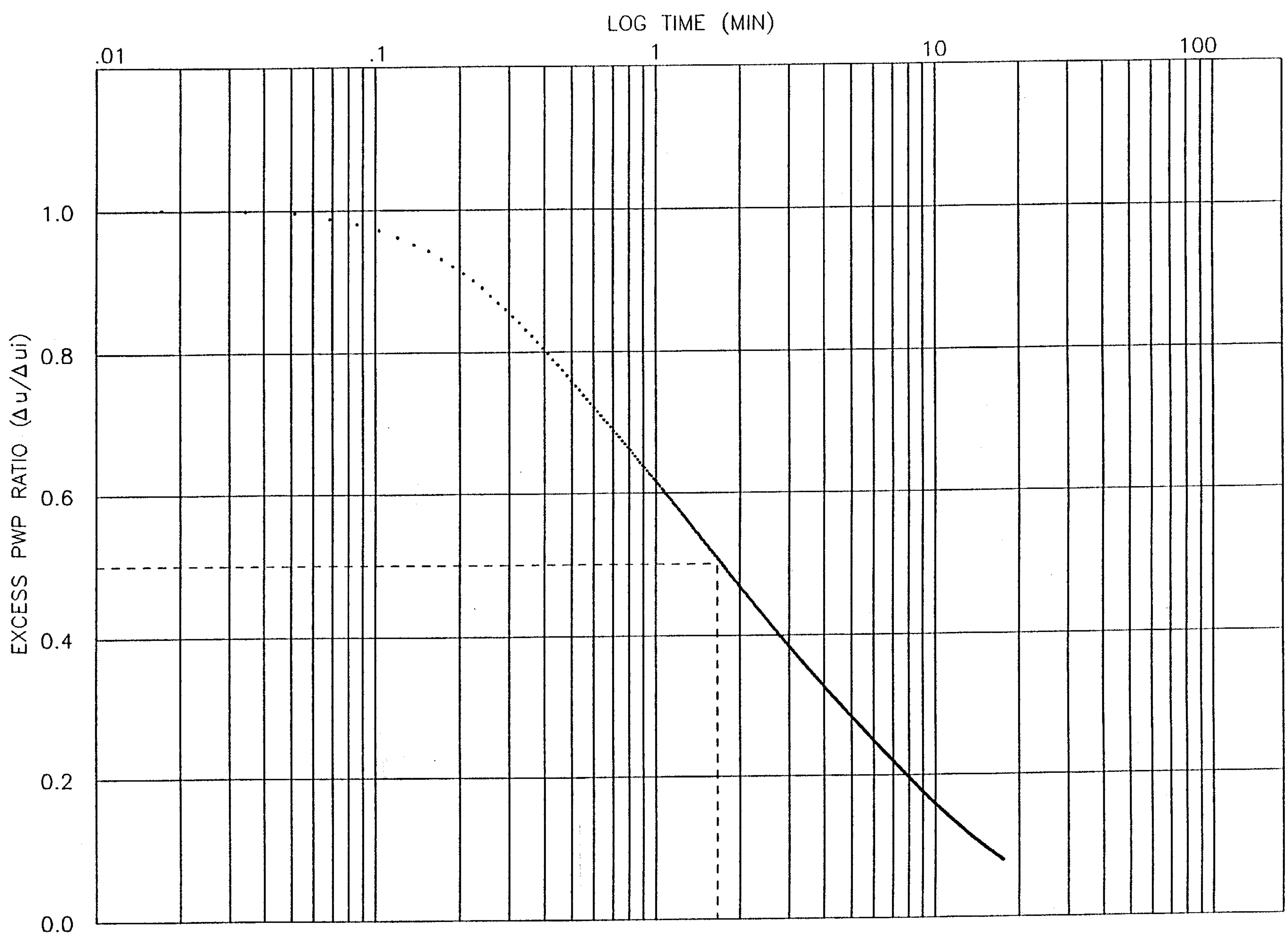


CPT NUMBER: U1P052
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 0.09

DEPTH: 72.8 FEET
DATE: 05-04-1995

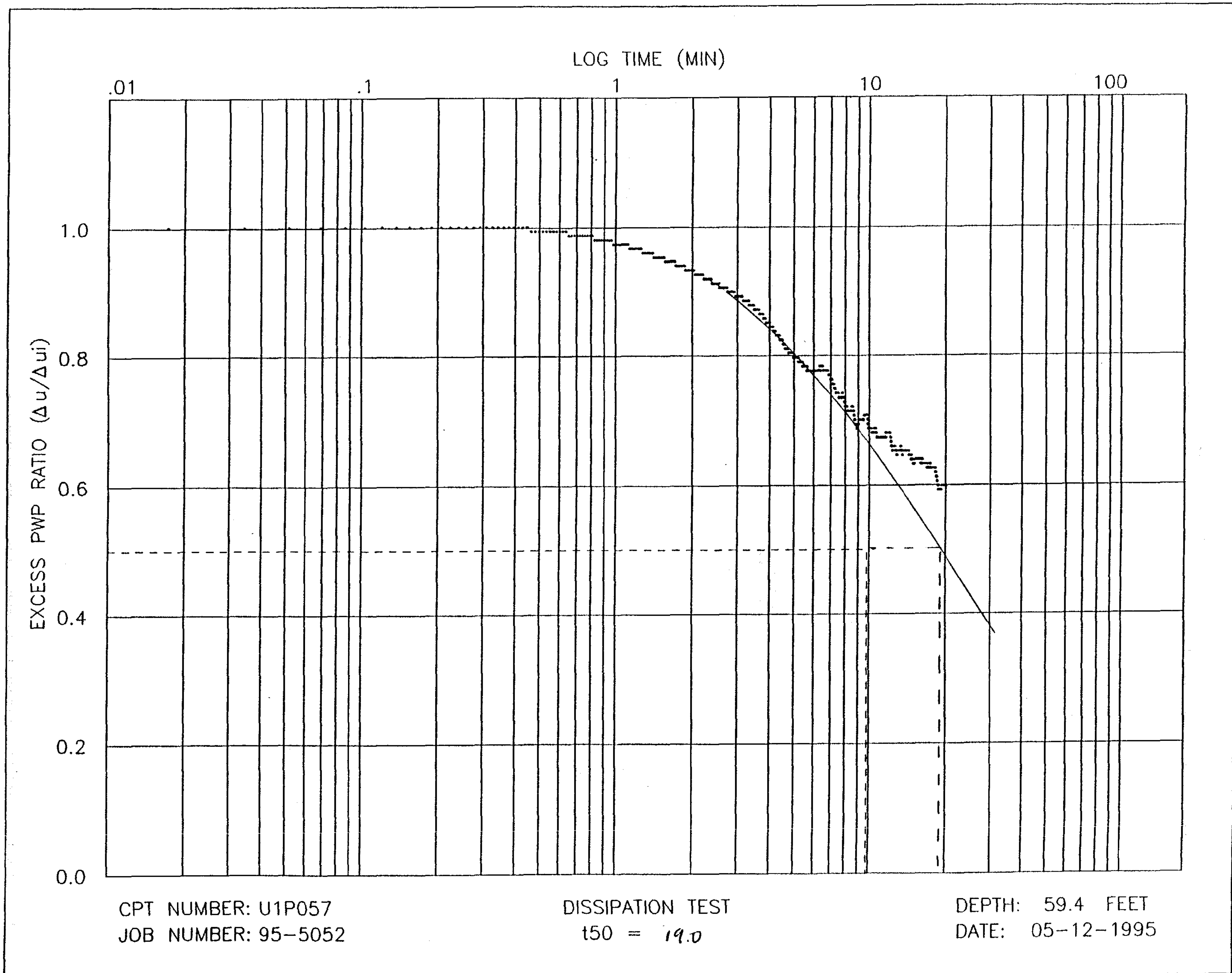
FUGRO GEOSCIENCES, INC.



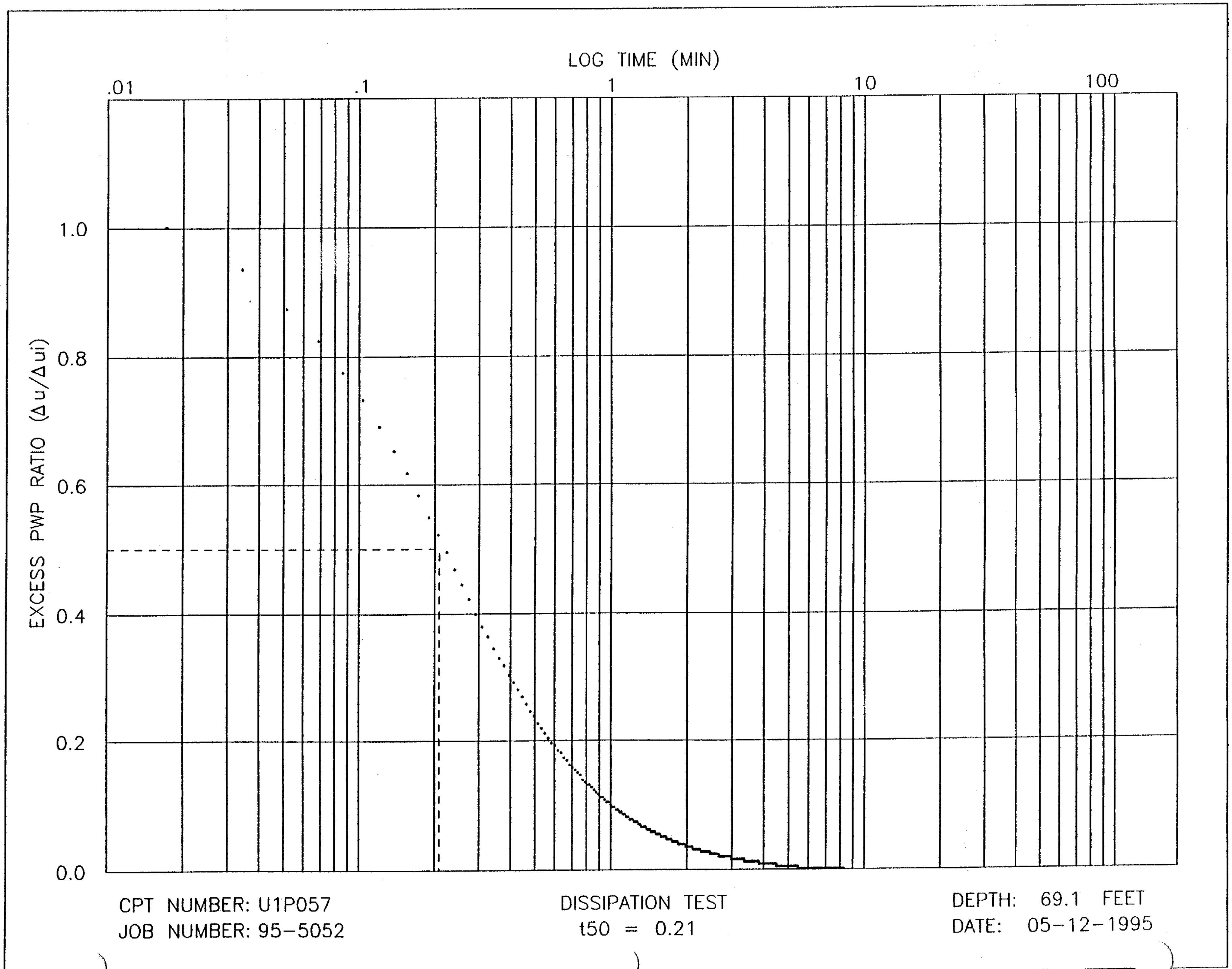
CPT NUMBER: U1P052
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 1.66

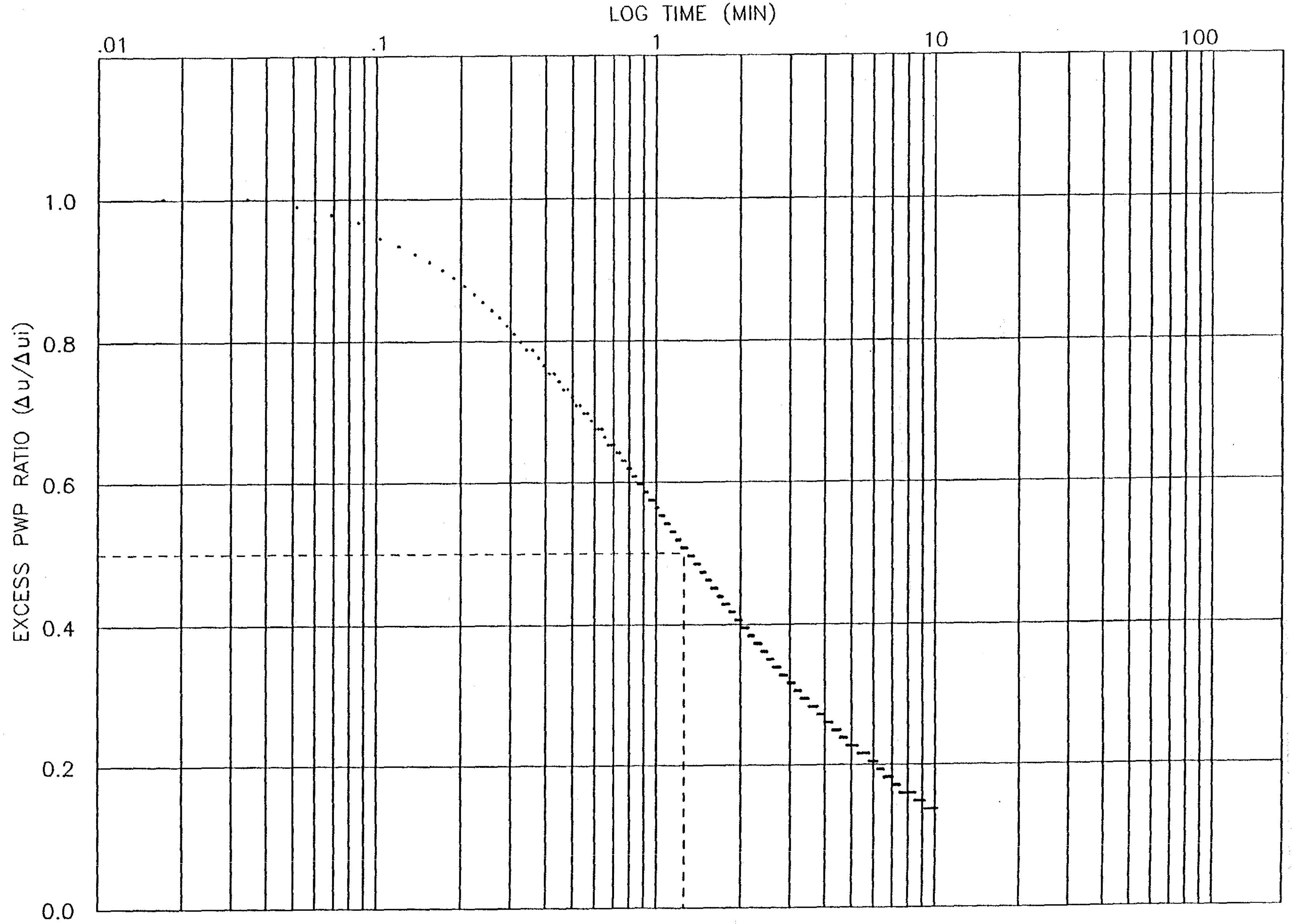
DEPTH: 85.1 FEET
DATE: 05-04-1995



FUGRO GEOSCIENCES, INC.



FUGRO G... CIENCES, INC.

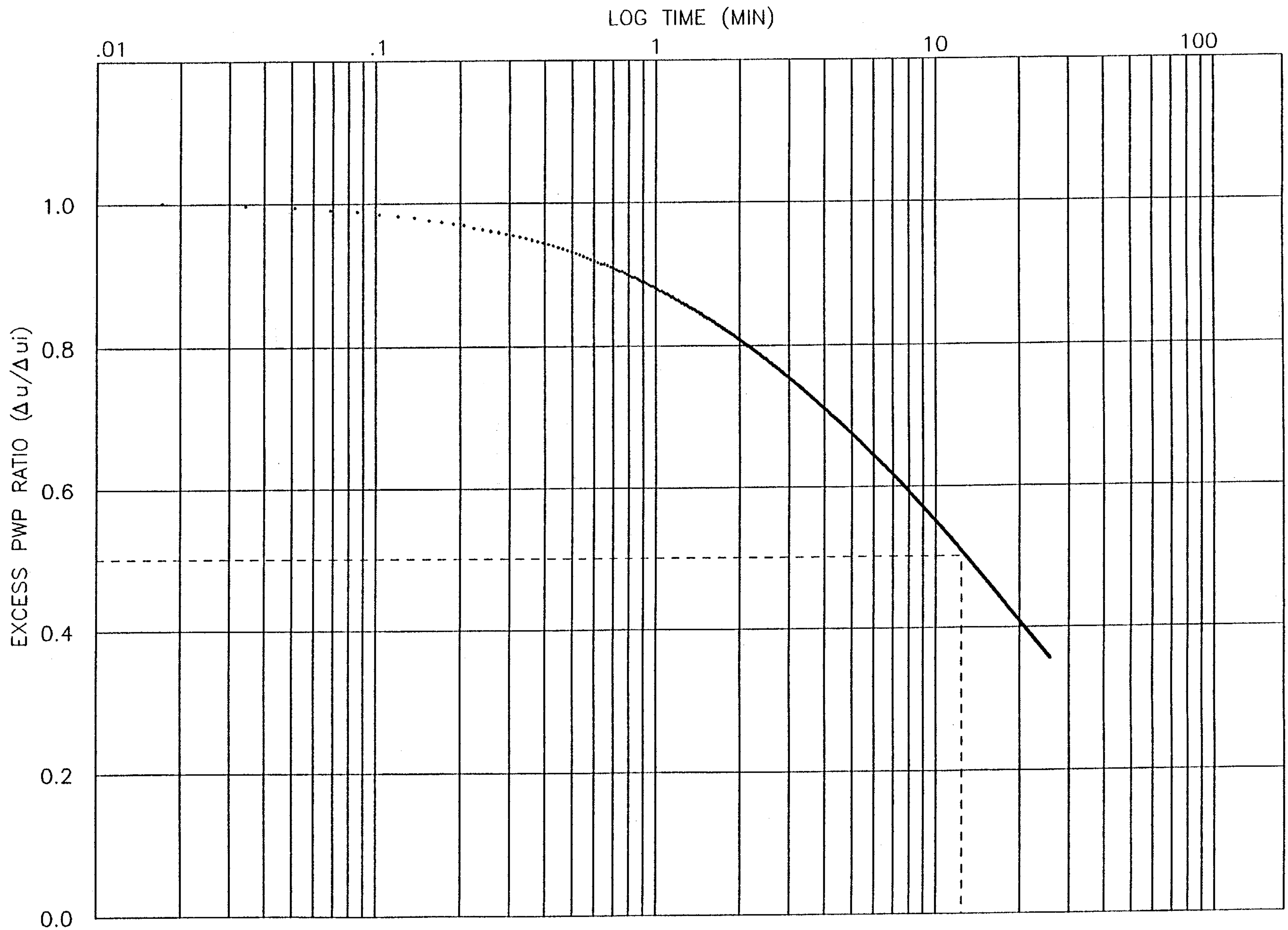


CPT NUMBER: U1P058
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 1.26

DEPTH: 46.6 FEET
DATE: 05-13-1995

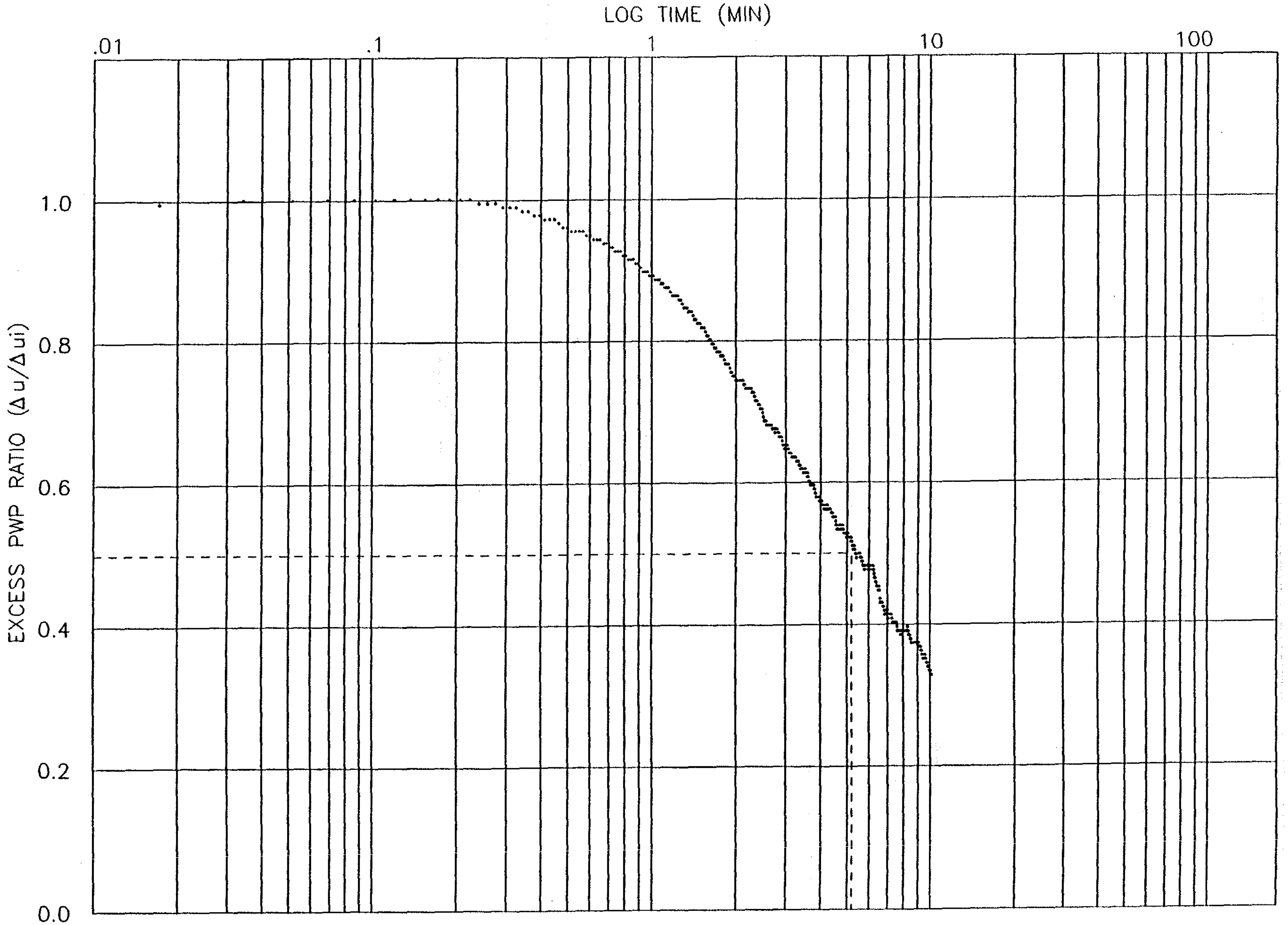
FUGRO GEOSCIENCES, INC.



CPT NUMBER: U1P058
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 12.36

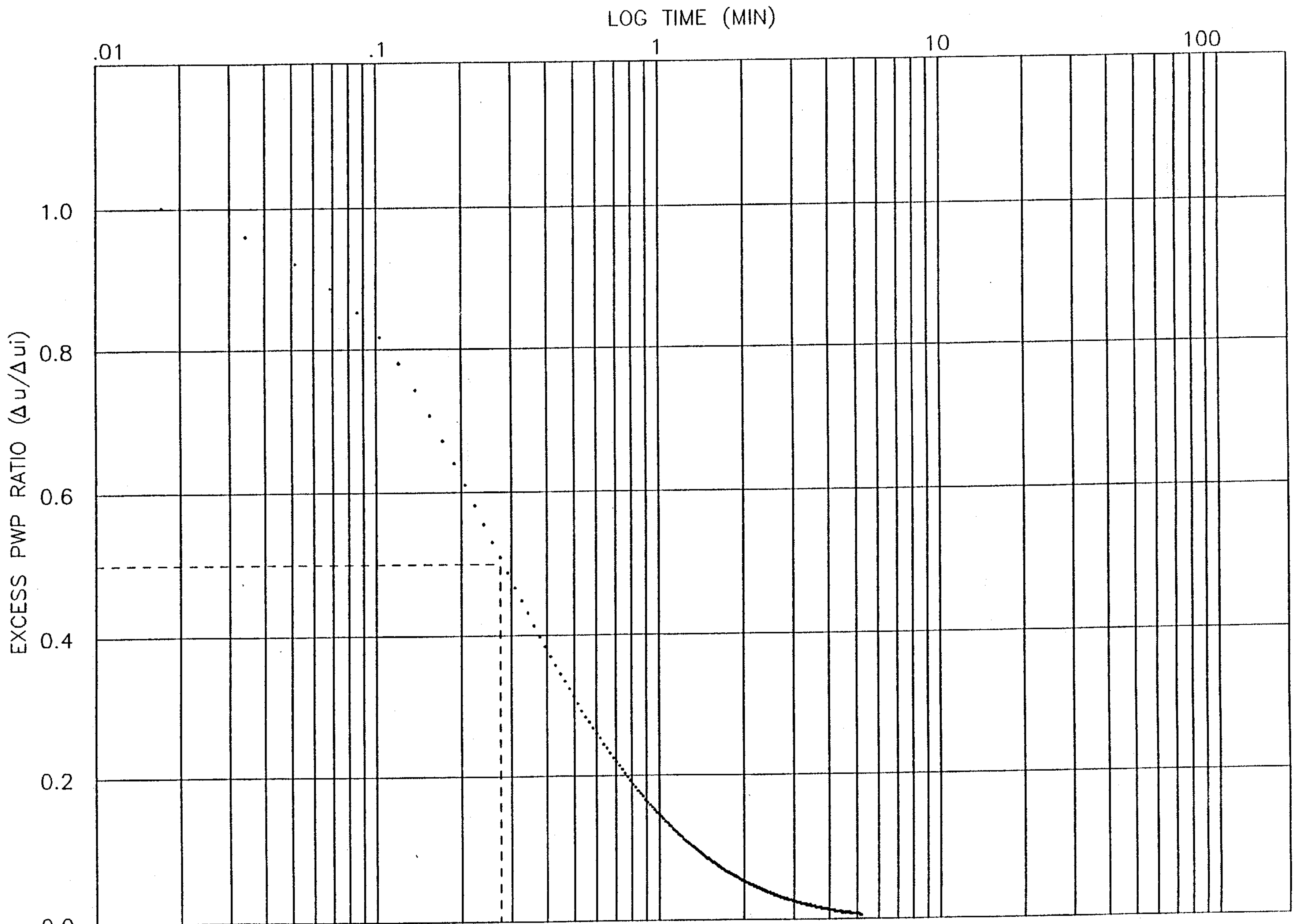
DEPTH: 56.5 FEET
DATE: 05-13-1995



CPT NUMBER: U1P059
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 5.19

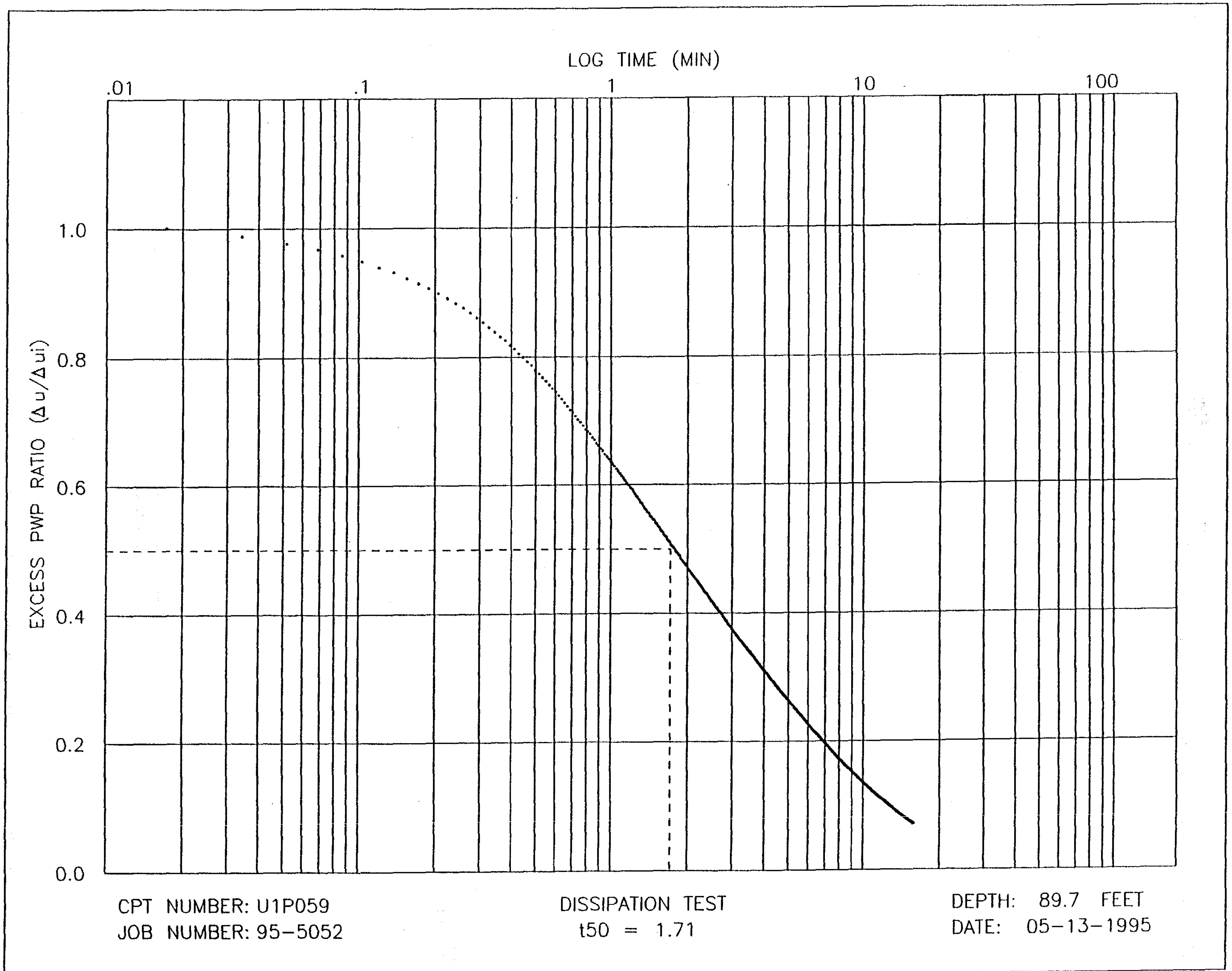
DEPTH: 58.3 FEET
DATE: 05-13-1995



CPT NUMBER: U1P059
JOB NUMBER: 95-5052

DISSIPATION TEST
t50 = 0.27

DEPTH: 65.7 FEET
DATE: 05-13-1995



FUGRO GEOSCIENCES, INC.

APPENDIX D

SOIL GAS SURVEY RESULTS

APPENDIX D-1

PASSIVE SOIL GAS SURVEY RESULTS

PASSIVE SOIL GAS SURVEY

NAVAL TRAINING CENTER ORLANDO
OU-1 SURVEY AREA
ORLANDO, FLORIDA

PREPARED FOR

ABB ENVIRONMENTAL SERVICES, INC.
2590 EXECUTIVE CENTER CIRCLE E
TALLAHASSEE, FLORIDA 32301

PREPARED BY

TARGET ENVIRONMENTAL SERVICES, INC.
9180 RUMSEY ROAD
COLUMBIA, MARYLAND 21045
(410) 992-6622

MAY 1995

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EXECUTIVE SUMMARY

On April 21-26, 1995, **TARGET Environmental Services, Inc. (TARGET)** conducted a soil gas survey at **Naval Training Center Orlando** in Orlando, Florida. A total of 303 passive soil gas samples and 14 duplicates were collected from Operable Unit 1 (OU-1) Survey Area from depths of 2 to 3 feet. The samples were analyzed on a gas chromatograph equipped with an electron capture detector (GC/ECD) for halogenated hydrocarbons and a flame ionization detector (GC/FID) for petroleum hydrocarbons. The objective of the survey was to identify and possibly delineate the extent of volatile organic contamination within the shallow subsurface of the survey areas.

Low to very low levels of petroleum hydrocarbons are present at scattered locations across the site, but do not suggest the presence of a significant petroleum hydrocarbon contamination problem in the shallow subsurface of the OU-1 Survey Area. Chlorinated hydrocarbon contamination was not evident in the shallow subsurface of the OU-1 Survey Area.

The chromatogram signatures of all the soil gas samples with detectable levels of FID hydrocarbons exhibited only small petroleum hydrocarbon peaks which were insufficient to allow chromatographic interpretation of the original contaminant product.

Introduction

ABB Environmental Services, Inc. (ABB) contracted **TARGET Environmental Services, Inc. (TARGET)** to perform a passive soil gas survey at the **Naval Training Center Orlando** in Orlando, Florida. The specific survey site was the Operable Unit 1 (OU-1) Survey Area. The objective of the survey was to identify and delineate the extent of possible volatile organic contamination within the shallow subsurface these sites.

The survey sampling grid was designed by **ABB**, and on-site changes to the sampling plan were directed by **ABB** in response to site conditions encountered by **TARGET** during sampling. The proposed sampling plan included passive soil gas samples to be collected from the site at depths of 2 to 3 feet and at an approximate grid spacing of 50 feet. The depth to groundwater was expected to be approximately 5 feet, but varying at some locations from 3 feet to 10 feet. The field phase of the survey was conducted on April 21-26, 1995.

Sample Collection and Analysis

A total of 303 passive soil gas samples and 14 duplicates were collected from the OU-1 Survey Area at depths of 2 to 3 feet at the locations shown in Figure 1. After multiple attempts, proposed soil gas Sample SG-362 was not installed due to impenetrable ground at that location. Proposed Sample SG-731 was not installed due to the hitting of a water sprinkler line during the installation attempt. A detailed explanation of the sampling procedure and a copy of the passive sample installation and retrieval documentation is provided in Appendix A.

All of the samples collected during the field phase of the survey were subjected to dual analyses. One analysis was conducted according to EPA Method 8010 (modified) on a gas chromatograph equipped with an electron capture detector (ECD), and using direct injection.

Specific analytes standardized for this analysis were:

1,1-dichloroethene (11DCE)
methylene chloride (CH_2Cl_2)
trans-1,2-dichloroethene (t12DCE)
1,1-dichloroethane (11DCA)
cis-1,2-dichloroethene (c12DCE)
chloroform ($CHCl_3$)
1,1,1-trichloroethane (111TCA)
carbon tetrachloride (CCl_4)
trichloroethene (TCE)
1,1,2-trichloroethane (112TCA)
tetrachloroethene (PCE)

The chlorinated hydrocarbons in this suite were chosen because of their common usage in industrial solvents, and/or their degradational relationship to commonly used compounds.

The second analysis was conducted according to EPA Method 8020 (modified) on a gas chromatograph equipped with a flame ionization detector (FID), and using direct injection. The analytes selected for standardization in this analysis were:

benzene
toluene
ethylbenzene
meta- and para- xylene
ortho- xylene

These compounds were chosen because of their utility in evaluating the presence of fuel products, or petroleum based solvents. An explanation of the laboratory procedures is provided in Appendix B.

The tabulated results of the laboratory analyses of the soil gas samples are reported in micrograms per liter-vapor (μg/l-v) in Tables 1 and 2. Although "micrograms per liter" is equivalent to "parts per billion (volume/volume)" in water analyses, they are not equivalent in gas analyses, due to the difference in the mass of equal volumes of water and gas matrices. The xylenes concentrations reported in Table 1 are the sum of the m- and p-xylene and the o-xylene concentrations for each sample. With **TARGET**s analytical run conditions, 11DCE/TCTFA and CCl_4/12DCA occur as co-eluting pairs and are reported in Table 2 in concentrations of 11DCE and CCl_4, respectively. The reporting limit for 11DCE was raised to 10 µg/l due to an artifact of the laboratory which was consistent for the batches of samples analyzed for this survey.

Quality Assurance/Quality Control (QA/QC) Evaluation

Field QA/QC Samples

Each trip blank consisted of a vial prepared for passive sampling enclosed in a heat-sealed aluminum pouch and was kept with the remaining undeployed passive sampling vials during each day's field activities until being opened, capped on-site and transported with a batch of samples to the laboratory. Equipment blanks were prepared at the start of each installation day's activities by removing a vial from its pouch and placing it within a PVC holding device. The holding device was wrapped in aluminum foil until the end of the day, when the vial was removed from the device, capped on-site and transported to the laboratory. Field duplicate samples were installed in the ground within a 1' lateral radius of every twentieth field sample. The laboratory results for all of these QA/QC samples are reported in Tables 1 and 2. Low level concentrations of petroleum hydrocarbons from an unknown source were detected in several of the field control blanks and trip blanks. In order to compensate for this blank contamination, the reporting limits for toluene, ethylbenzene and xylenes were raised (to levels above those detected in the blanks, see Table 1) for all of the soil gas samples collected during the survey.

Laboratory QA/QC Samples

To document analytical repeatability, a duplicate laboratory analysis was performed on every tenth field sample. Laboratory blanks of nitrogen gas were also analyzed after every tenth field sample. The results of these analyses are reported in Tables 1 and 2. Concentrations of all analytes were below the reporting limit in all laboratory blanks.

Results and Interpretation

In order to provide graphic presentation of the results, selected individual data sets in Table 1 have been mapped and contoured to produce Figures 2 through 5. Dashed contours are used where patterns are extrapolated into areas of less complete data, or as auxiliary contours. Map sample points with no data shown indicate that the analyte concentrations in the sample were below the reporting limit. An explanation of the terminology used in this report is provided in Appendix C.

GC/FID analysis of the soil gas samples collected from OU-1 Survey Area revealed a very low level of Total FID Volatiles as Naphtha (Figure 2) in Sample SG-668 collected from the northwestern section of the site. Benzene, toluene and xylenes (Figures 3 through 5) were present at low to very low concentrations at several scattered locations throughout the survey area. A very low level of ethylbenzene (not mapped) occurred only in Sample SG-790 from the eastern side of the survey area.

The FID chromatogram signatures of the samples with detectable levels of volatiles revealed only small peaks representing low to very low levels of petroleum hydrocarbons which are insufficient to allow chromatographic interpretation of the original product. The very low levels of volatile hydrocarbons observed at scattered locations at this site do not suggest the presence of a significant petroleum hydrocarbon contamination problem in the shallow subsurface of the OU-1 Survey Area.

GC/ECD analysis revealed that none of the standardized chlorinated compounds were present above their respective reporting limits in any of the passive soil gas samples collected from the OU-1 Survey Area.

Conclusions

- Low to very low levels of petroleum hydrocarbons are present at scattered locations across the site, but do not suggest the presence of a significant petroleum hydrocarbon contamination problem in the shallow subsurface of the OU-1 Survey Area.

- Chlorinated hydrocarbon contamination was not evident in the shallow subsurface of the OU-1 Survey Area.

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-201	<1.0	<11	<3.0	<14	<50
SG-202	<1.0	<11	<3.0	<14	<50
SG-203	<1.0	<11	<3.0	<14	<50
SG-204	<1.0	<11	<3.0	<14	<50
SG-205	<1.0	<11	<3.0	<14	<50
SG-206	<1.0	<11	<3.0	<14	<50
SG-207	<1.0	<11	<3.0	<14	<50
SG-208	<1.0	<11	<3.0	<14	<50
SG-209	<1.0	<11	<3.0	<14	<50
SG-210	<1.0	<11	<3.0	<14	<50
SG-211	<1.0	<11	<3.0	<14	<50
SG-212	<1.0	<11	<3.0	<14	<50
SG-213	<1.0	<11	<3.0	<14	<50
SG-214	<1.0	<11	<3.0	<14	<50
SG-215	<1.0	<11	<3.0	<14	<50
SG-216	<1.0	<11	<3.0	<14	<50
SG-217	<1.0	<11	<3.0	<14	<50
SG-218	<1.0	<11	<3.0	<14	<50
SG-219	<1.0	<11	<3.0	<14	<50
SG-220	<1.0	<11	<3.0	<14	<50
SG-220D	<1.0	<11	<3.0	<14	<50
SG-221	<1.0	<11	<3.0	<14	<50
SG-222	<1.0	<11	<3.0	<14	<50
SG-223	<1.0	<11	<3.0	<14	<50
SG-224	<1.0	<11	<3.0	<14	<50
SG-225	<1.0	<11	<3.0	<14	<50
SG-226	<1.0	<11	<3.0	<14	<50
SG-227	<1.0	<11	<3.0	<14	<50
SG-228	<1.0	<11	<3.0	<14	<50
SG-229	<1.0	<11	<3.0	<14	<50
SG-230	<1.0	<11	<3.0	<14	<50
SG-231	<1.0	<11	<3.0	<14	<50
SG-232	<1.0	<11	<3.0	<14	<50
SG-233	<1.0	<11	<3.0	<14	<50
SG-234	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	**1.0**	**11**	**3.0**	**14**	**50**
SG-235	<1.0	<11	<3.0	<14	<50
SG-236	<1.0	<11	<3.0	<14	<50
SG-237	<1.0	<11	<3.0	<14	<50
SG-238	<1.0	<11	<3.0	<14	<50
SG-239	<1.0	<11	<3.0	<14	<50
SG-240	<1.0	<11	<3.0	<14	<50
SG-240D	<1.0	<11	<3.0	<14	<50
SG-241	<1.0	<11	<3.0	<14	<50
SG-242	<1.0	<11	<3.0	<14	<50
SG-243	<1.0	<11	<3.0	<14	<50
SG-244	<1.0	<11	<3.0	<14	<50
SG-245	<1.0	<11	<3.0	<14	<50
SG-246	<1.0	<11	<3.0	<14	<50
SG-247	<1.0	<11	<3.0	<14	<50
SG-248	<1.0	<11	<3.0	<14	<50
SG-249	<1.0	<11	<3.0	<14	<50
SG-250	<1.0	<11	<3.0	<14	<50
SG-251	<1.0	<11	<3.0	<14	<50
SG-252	<1.0	<11	<3.0	<14	<50
SG-253	<1.0	<11	<3.0	<14	<50
SG-254	<1.0	<11	<3.0	<14	<50
SG-255	<1.0	<11	<3.0	<14	<50
SG-256	<1.0	<11	<3.0	<14	<50
SG-257	<1.0	<11	<3.0	<14	<50
SG-258	<1.0	<11	<3.0	<14	<50
SG-259	<1.0	<11	<3.0	<14	<50
SG-260	<1.0	<11	<3.0	<14	<50
SG-260D	<1.0	<11	<3.0	<14	<50
SG-261	<1.0	<11	<3.0	<14	<50
SG-262	<1.0	<11	<3.0	<14	<50
SG-263	<1.0	<11	<3.0	<14	<50
SG-264	<1.0	<11	<3.0	<14	<50
SG-265	<1.0	<11	<3.0	<14	<50
SG-266	<1.0	<11	<3.0	<14	<50
SG-267	<1.0	<11	<3.0	<14	<50

**** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.***

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-268	<1.0	<11	<3.0	<14	<50
SG-269	<1.0	<11	<3.0	<14	<50
SG-270	<1.0	<11	<3.0	<14	<50
SG-271	<1.0	<11	<3.0	<14	<50
SG-272	<1.0	<11	<3.0	<14	<50
SG-273	<1.0	<11	<3.0	<14	<50
SG-274	<1.0	<11	<3.0	<14	<50
SG-275	<1.0	<11	<3.0	<14	<50
SG-276	<1.0	<11	<3.0	<14	<50
SG-277	<1.0	<11	<3.0	<14	<50
SG-278	<1.0	<11	<3.0	<14	<50
SG-279	<1.0	<11	<3.0	<14	<50
SG-280	<1.0	<11	<3.0	<14	<50
SG-280D	<1.0	<11	<3.0	<14	<50
SG-281	<1.0	<11	<3.0	<14	<50
SG-282	<1.0	<11	<3.0	<14	<50
SG-283	<1.0	<11	<3.0	<14	<50
SG-284	<1.0	<11	<3.0	<14	<50
SG-285	<1.0	<11	<3.0	<14	<50
SG-286	<1.0	<11	<3.0	<14	<50
SG-287	<1.0	<11	<3.0	<14	<50
SG-288	<1.0	<11	<3.0	<14	<50
SG-289	<1.0	<11	<3.0	<14	<50
SG-290	<1.0	<11	<3.0	<14	<50
SG-291	<1.0	<11	<3.0	<14	<50
SG-292	<1.0	<11	<3.0	<14	<50
SG-293	<1.0	<11	<3.0	<14	<50
SG-294	<1.0	<11	<3.0	<14	<50
SG-295	<1.0	<11	<3.0	<14	<50
SG-296	<1.0	<11	<3.0	<14	<50
SG-297	<1.0	<11	<3.0	<14	<50
SG-298	<1.0	<11	<3.0	<14	<50
SG-299	<1.0	<11	<3.0	<14	<50
SG-300	<1.0	<11	<3.0	<14	<50
SG-300D	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-301	<1.0	<11	<3.0	<14	<50
SG-302	<1.0	<11	<3.0	<14	<50
SG-303	<1.0	<11	<3.0	<14	<50
SG-304	<1.0	<11	<3.0	<14	<50
SG-305	<1.0	<11	<3.0	<14	<50
SG-306	<1.0	<11	<3.0	<14	<50
SG-307	<1.0	<11	<3.0	<14	<50
SG-308	<1.0	<11	<3.0	<14	<50
SG-309	<1.0	<11	<3.0	<14	<50
SG-310	<1.0	<11	<3.0	<14	<50
SG-311	<1.0	<11	<3.0	<14	<50
SG-312	<1.0	<11	<3.0	<14	<50
SG-313	<1.0	<11	<3.0	<14	<50
SG-314	<1.0	<11	<3.0	<14	<50
SG-315	<1.0	<11	<3.0	<14	<50
SG-316	<1.0	<11	<3.0	<14	<50
SG-317	<1.0	<11	<3.0	<14	<50
SG-318	<1.0	<11	<3.0	<14	<50
SG-319	<1.0	<11	<3.0	<14	<50
SG-320	<1.0	<11	<3.0	<14	<50
SG-320D	<1.0	<11	<3.0	<14	<50
SG-321	<1.0	<11	<3.0	<14	<50
SG-322	<1.0	<11	<3.0	<14	<50
SG-323	<1.0	<11	<3.0	<14	<50
SG-324	<1.0	<11	<3.0	<14	<50
SG-325	<1.0	<11	<3.0	<14	<50
SG-326	<1.0	<11	<3.0	<14	<50
SG-327	<1.0	<11	<3.0	<14	<50
SG-328	<1.0	<11	<3.0	<14	<50
SG-329	<1.0	<11	<3.0	<14	<50
SG-330	<1.0	<11	<3.0	<14	<50
SG-331	<1.0	<11	<3.0	<14	<50
SG-332	<1.0	<11	<3.0	<14	<50
SG-333	<1.0	<11	<3.0	<14	<50
SG-334	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (μg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-335	<1.0	<11	<3.0	<14	<50
SG-336	<1.0	<11	<3.0	<14	<50
SG-337	<1.0	<11	<3.0	<14	<50
SG-338	<1.0	<11	<3.0	<14	<50
SG-339	<1.0	<11	<3.0	<14	<50
SG-340	<1.0	<11	<3.0	<14	<50
SG-340D	<1.0	<11	<3.0	<14	<50
SG-341	<1.0	<11	<3.0	<14	<50
SG-342	<1.0	<11	<3.0	<14	<50
SG-343	<1.0	<11	<3.0	<14	<50
SG-344	<1.0	<11	<3.0	<14	<50
SG-345	<1.0	<11	<3.0	<14	<50
SG-346	<1.0	<11	<3.0	<14	<50
SG-347	<1.0	<11	<3.0	<14	<50
SG-348	<1.0	<11	<3.0	<14	<50
SG-349	<1.0	<11	<3.0	<14	<50
SG-350	<1.0	<11	<3.0	<14	<50
SG-351	<1.0	<11	<3.0	<14	<50
SG-352	<1.0	<11	<3.0	<14	<50
SG-353	<1.0	<11	<3.0	<14	<50
SG-354	<1.0	<11	<3.0	<14	<50
SG-355	<1.0	<11	<3.0	<14	<50
SG-356	<1.0	<11	<3.0	<14	<50
SG-357	<1.0	<11	<3.0	<14	<50
SG-358	<1.0	<11	<3.0	<14	<50
SG-359	<1.0	<11	<3.0	<14	<50
SG-360	<1.0	<11	<3.0	<14	<50
SG-360D	<1.0	<11	<3.0	<14	<50
SG-361	<1.0	<11	<3.0	<14	<50
SG-363	<1.0	<11	<3.0	<14	<50
SG-364	<1.0	<11	<3.0	<14	<50
SG-365	<1.0	<11	<3.0	<14	<50
SG-366	<1.0	<11	<3.0	<14	<50
SG-367	<1.0	<11	<3.0	<14	<50
SG-368	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-369	<1.0	<11	<3.0	<14	<50
SG-370	<1.0	<11	<3.0	<14	<50
SG-371	<1.0	<11	<3.0	<14	<50
SG-372	<1.0	<11	<3.0	<14	<50
SG-373	<1.0	<11	<3.0	<14	<50
SG-374	<1.0	<11	<3.0	<14	<50
SG-375	<1.0	<11	<3.0	<14	<50
SG-376	<1.0	<11	<3.0	<14	<50
SG-377	<1.0	<11	<3.0	<14	<50
SG-378	<1.0	<11	<3.0	<14	<50
SG-379	<1.0	<11	<3.0	<14	<50
SG-666	<1.0	<11	<3.0	<14	<50
SG-667	<1.0	<11	<3.0	<14	<50
SG-668	3.0	13	<3.0	<14	62
SG-669	1.8	<11	<3.0	<14	<50
SG-670	<1.0	<11	<3.0	<14	<50
SG-671	<1.0	<11	<3.0	<14	<50
SG-672	<1.0	<11	<3.0	<14	<50
SG-673	<1.0	<11	<3.0	<14	<50
SG-674	<1.0	<11	<3.0	<14	<50
SG-675	<1.0	<11	<3.0	<14	<50
SG-676	<1.0	<11	<3.0	<14	<50
SG-677	<1.0	<11	<3.0	<14	<50
SG-678	<1.0	<11	<3.0	<14	<50
SG-679	<1.0	<11	<3.0	<14	<50
SG-680	<1.0	<11	<3.0	<14	<50
SG-680D	<1.0	<11	<3.0	<14	<50
SG-681	<1.0	12	<3.0	<14	<50
SG-682	<1.0	<11	<3.0	<14	<50
SG-683	<1.0	<11	<3.0	<14	<50
SG-684	<1.0	<11	<3.0	<14	<50
SG-685	<1.0	<11	<3.0	<14	<50
SG-686	<1.0	<11	<3.0	<14	<50
SG-687	<1.0	<11	<3.0	<14	<50
SG-688	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-689	<1.0	<11	<3.0	<14	<50
SG-690	<1.0	<11	<3.0	<14	<50
SG-691	2.2	14	<3.0	<14	<50
SG-692	9.0	<11	<3.0	<14	<50
SG-693	<1.0	<11	<3.0	<14	<50
SG-694	<1.0	<11	<3.0	<14	<50
SG-695	<1.0	<11	<3.0	<14	<50
SG-696	<1.0	<11	<3.0	<14	<50
SG-697	<1.0	<11	<3.0	<14	<50
SG-698	<1.0	<11	<3.0	15	<50
SG-699	<1.0	<11	<3.0	<14	<50
SG-700	1.2	12	<3.0	15	<50
SG-700D	<1.0	<11	<3.0	<14	<50
SG-701	<1.0	<11	<3.0	<14	<50
SG-702	<1.0	<11	<3.0	<14	<50
SG-703	<1.0	<11	<3.0	<14	<50
SG-704	<1.0	<11	<3.0	<14	<50
SG-705	<1.0	<11	<3.0	<14	<50
SG-706	<1.0	<11	<3.0	<14	<50
SG-707	<1.0	<11	<3.0	<14	<50
SG-708	<1.0	<11	<3.0	<14	<50
SG-709	<1.0	<11	<3.0	<14	<50
SG-710	<1.0	<11	<3.0	<14	<50
SG-711	<1.0	<11	<3.0	<14	<50
SG-712	<1.0	<11	<3.0	<14	<50
SG-713	<1.0	<11	<3.0	<14	<50
SG-714	<1.0	<11	<3.0	<14	<50
SG-715	<1.0	<11	<3.0	<14	<50
SG-716	<1.0	<11	<3.0	<14	<50
SG-717	1.1	12	<3.0	14	<50
SG-718	<1.0	<11	<3.0	<14	<50
SG-719	1.3	12	<3.0	14	<50
SG-720	<1.0	<11	<3.0	<14	<50
SG-720D	<1.0	<11	<3.0	<14	<50
SG-721	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-722	<1.0	<11	<3.0	<14	<50
SG-723	<1.0	<11	<3.0	<14	<50
SG-724	<1.0	<11	<3.0	<14	<50
SG-725	<1.0	<11	<3.0	<14	<50
SG-726	<1.0	<11	<3.0	<14	<50
SG-727	<1.0	<11	<3.0	<14	<50
SG-728	<1.0	<11	<3.0	<14	<50
SG-729	<1.0	<11	<3.0	<14	<50
SG-730	<1.0	<11	<3.0	<14	<50
SG-732	<1.0	<11	<3.0	<14	<50
SG-733	<1.0	<11	<3.0	<14	<50
SG-734	<1.0	<11	<3.0	<14	<50
SG-735	<1.0	<11	<3.0	<14	<50
SG-736	<1.0	<11	<3.0	<14	<50
SG-737	<1.0	<11	<3.0	<14	<50
SG-738	<1.0	<11	<3.0	<14	<50
SG-739	<1.0	<11	<3.0	<14	<50
SG-740	<1.0	<11	<3.0	<14	<50
SG-740D	<1.0	<11	<3.0	<14	<50
SG-741	<1.0	<11	<3.0	<14	<50
SG-742	<1.0	<11	<3.0	<14	<50
SG-743	<1.0	<11	<3.0	<14	<50
SG-744	<1.0	<11	<3.0	<14	<50
SG-745	<1.0	<11	<3.0	<14	<50
SG-746	<1.0	<11	<3.0	<14	<50
SG-747	<1.0	<11	<3.0	<14	<50
SG-748	<1.0	<11	<3.0	<14	<50
SG-749	<1.0	<11	<3.0	<14	<50
SG-750	<1.0	<11	<3.0	<14	<50
SG-751	<1.0	<11	<3.0	<14	<50
SG-752	<1.0	<11	<3.0	<14	<50
SG-753	<1.0	<11	<3.0	<14	<50
SG-754	<1.0	<11	<3.0	<14	<50
SG-755	<1.0	<11	<3.0	<14	<50
SG-756	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-757	<1.0	<11	<3.0	<14	<50
SG-758	<1.0	<11	<3.0	<14	<50
SG-759	<1.0	<11	<3.0	<14	<50
SG-760	<1.0	<11	<3.0	<14	<50
SG-760D	<1.0	<11	<3.0	<14	<50
SG-761	<1.0	<11	<3.0	<14	<50
SG-762	<1.0	<11	<3.0	<14	<50
SG-763	<1.0	<11	<3.0	<14	<50
SG-764	<1.0	<11	<3.0	<14	<50
SG-765	<1.0	<11	<3.0	<14	<50
SG-766	<1.0	<11	<3.0	<14	<50
SG-767	<1.0	<11	<3.0	<14	<50
SG-768	<1.0	<11	<3.0	<14	<50
SG-769	<1.0	<11	<3.0	<14	<50
SG-770	<1.0	<11	<3.0	<14	<50
SG-771	<1.0	<11	<3.0	<14	<50
SG-772	<1.0	<11	<3.0	<14	<50
SG-773	<1.0	<11	<3.0	<14	<50
SG-774	<1.0	<11	<3.0	<14	<50
SG-775	<1.0	<11	<3.0	<14	<50
SG-776	<1.0	<11	<3.0	<14	<50
SG-777	<1.0	<11	<3.0	<14	<50
SG-778	<1.0	<11	<3.0	<14	<50
SG-779	<1.0	<11	<3.0	<14	<50
SG-780	<1.0	<11	<3.0	<14	<50
SG-780D	<1.0	<11	<3.0	<14	<50
SG-781	<1.0	<11	<3.0	<14	<50
SG-782	<1.0	<11	<3.0	<14	<50
SG-783	<1.0	<11	<3.0	<14	<50
SG-784	<1.0	11	<3.0	<14	<50
SG-785	<1.0	<11	<3.0	<14	<50
SG-786	<1.0	<11	<3.0	<14	<50
SG-787	<1.0	<11	<3.0	<14	<50
SG-788	<1.0	<11	<3.0	<14	<50
SG-789	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-790	1.6	16	3.7	20	<50
SG-791	<1.0	<11	<3.0	<14	<50
FIELD CONTROL SAMPLES					
B-05	<1.0	<11	<3.0	<14	<50
B-06	<1.0	<11	<3.0	<14	<50
TB-04	<1.0	<11	<3.0	<14	<50
TB-05	<1.0	<11	<3.0	<14	<50
LABORATORY DUPLICATE ANALYSIS					
SG-207	<1.0	<11	<3.0	<14	<50
SG-207R	<1.0	<11	<3.0	<14	<50
SG-217	<1.0	<11	<3.0	<14	<50
SG-217R	<1.0	<11	<3.0	<14	<50
SG-225	<1.0	<11	<3.0	<14	<50
SG-225R	<1.0	<11	<3.0	<14	<50
SG-235	<1.0	<11	<3.0	<14	<50
SG-235R	<1.0	<11	<3.0	<14	<50
SG-244	<1.0	<11	<3.0	<14	<50
SG-244R	<1.0	<11	<3.0	<14	<50
SG-254	<1.0	<11	<3.0	<14	<50
SG-254R	<1.0	<11	<3.0	<14	<50
SG-267	<1.0	<11	<3.0	<14	<50
SG-267R	<1.0	<11	<3.0	<14	<50
SG-273	<1.0	<11	<3.0	<14	<50
SG-273R	<1.0	<11	<3.0	<14	<50
SG-287	<1.0	<11	<3.0	<14	<50
SG-287R	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	**1.0**	**11**	**3.0**	**14**	**50**
SG-297	<1.0	<11	<3.0	<14	<50
SG-297R	<1.0	<11	<3.0	<14	<50
SG-310	<1.0	<11	<3.0	<14	<50
SG-310R	<1.0	<11	<3.0	<14	<50
SG-321	<1.0	<11	<3.0	<14	<50
SG-321R	<1.0	<11	<3.0	<14	<50
SG-331	<1.0	<11	<3.0	<14	<50
SG-331R	<1.0	<11	<3.0	<14	<50
SG-341	<1.0	<11	<3.0	<14	<50
SG-341R	<1.0	<11	<3.0	<14	<50
SG-351	<1.0	<11	<3.0	<14	<50
SG-351R	<1.0	<11	<3.0	<14	<50
SG-365	<1.0	<11	<3.0	<14	<50
SG-365R	<1.0	<11	<3.0	<14	<50
SG-377	<1.0	<11	<3.0	<14	<50
SG-377R	<1.0	<11	<3.0	<14	<50
SG-669	1.8	<11	<3.0	<14	<50
SG-669R	2.1	<11	<3.0	<14	<50
SG-670	<1.0	<11	<3.0	<14	<50
SG-670R	<1.0	<11	<3.0	<14	<50
SG-688	<1.0	<11	<3.0	<14	<50
SG-688R	<1.0	<11	<3.0	<14	<50
SG-689	<1.0	<11	<3.0	<14	<50
SG-689R	<1.0	<11	<3.0	<14	<50
SG-705	<1.0	<11	<3.0	<14	<50
SG-705R	<1.0	<11	<3.0	<14	<50
SG-715	<1.0	<11	<3.0	<14	<50
SG-715R	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-724	<1.0	<11	<3.0	<14	<50
SG-724R	<1.0	<11	<3.0	<14	<50
SG-733	<1.0	<11	<3.0	<14	<50
SG-733R	<1.0	<11	<3.0	<14	<50
SG-740	<1.0	<11	<3.0	<14	<50
SG-740R	<1.0	<11	<3.0	<14	<50
SG-760	<1.0	<11	<3.0	<14	<50
SG-760R	<1.0	<11	<3.0	<14	<50
SG-770	<1.0	<11	<3.0	<14	<50
SG-770R	<1.0	<11	<3.0	<14	<50
B-05	<1.0	<11	<3.0	<14	<50
B-05R	<1.0	<11	<3.0	<14	<50

LABORATORY BLANKS

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
SG-207B	<1.0	<11	<3.0	<14	<50
SG-217B	<1.0	<11	<3.0	<14	<50
SG-225B	<1.0	<11	<3.0	<14	<50
SG-235B	<1.0	<11	<3.0	<14	<50
SG-244B	<1.0	<11	<3.0	<14	<50
SG-254B	<1.0	<11	<3.0	<14	<50
SG-267B	<1.0	<11	<3.0	<14	<50
SG-273B	<1.0	<11	<3.0	<14	<50
SG-287B	<1.0	<11	<3.0	<14	<50
SG-297B	<1.0	<11	<3.0	<14	<50
SG-310B	<1.0	<11	<3.0	<14	<50
SG-321B	<1.0	<11	<3.0	<14	<50
SG-331B	<1.0	<11	<3.0	<14	<50
SG-341B	<1.0	<11	<3.0	<14	<50
SG-351B	<1.0	<11	<3.0	<14	<50
SG-365B	<1.0	<11	<3.0	<14	<50
SG-377B	<1.0	<11	<3.0	<14	<50
SG-669B	<1.0	<11	<3.0	<14	<50
SG-670B	<1.0	<11	<3.0	<14	<50
SG-688B	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (µg/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID AS NAPHTHA
REPORTING LIMIT	1.0	11	3.0	14	50
SG-689B	<1.0	<11	<3.0	<14	<50
SG-705B	<1.0	<11	<3.0	<14	<50
SG-715B	<1.0	<11	<3.0	<14	<50
SG-724B	<1.0	<11	<3.0	<14	<50
SG-733B	<1.0	<11	<3.0	<14	<50
SG-740B	<1.0	<11	<3.0	<14	<50
SG-760B	<1.0	<11	<3.0	<14	<50
SG-770B	<1.0	<11	<3.0	<14	<50
B-05B	<1.0	<11	<3.0	<14	<50

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE AVERAGE RESPONSE FACTOR FOR NAPHTHA.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-201	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-202	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-203	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-204	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-205	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-206	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-207	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-208	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-209	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-210	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-211	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-212	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-213	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-214	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-215	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-216	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-217	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-218	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-219	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-220	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-220D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-221	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-222	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-223	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-224	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-225	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-226	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-227	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-228	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-229	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene
11DCA = 1,1-dichloroethane
111TCA = 1,1,1-trichloroethane
112TCA = 1,1,2-trichloroethane
CH2Cl2 = methylene chloride
c12DCE = cis-1,2-dichloroethene
CCl4 = carbon tetrachloride
PCE = tetrachloroethene
t12DCE = trans-1,2-dichloroethene
CHCl3 = chloroform
TCE = trichloroethene

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-230	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-231	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-232	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-233	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-234	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-235	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-236	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-237	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-238	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-239	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-240	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-240D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-241	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-242	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-243	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	[illegible]0
SG-244	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-245	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-246	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-247	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-248	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-249	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-250	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-251	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-252	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-253	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-254	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-255	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-256	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-257	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-258	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.

11DCE = 1,1-dichloroethene
CH2Cl2 = methylene chloride
t12DCE = trans-1,2-dichloroethene
11DCA = 1,1-dichloroethane
c12DCE = cis-1,2-dichloroethene
CHCl3 = chloroform
111TCA = 1,1,1-trichloroethane
CCl4 = carbon tetrachloride
TCE = trichloroethene
112TCA = 1,1,2-trichloroethane
PCE = tetrachloroethene

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (μg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-259	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-260	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-260D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-261	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-262	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-263	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-264	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-265	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-266	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-267	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-268	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-269	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-270	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-271	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-272	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-273	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-274	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-275	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-276	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-277	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-278	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-279	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-280	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-280D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-281	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-282	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-283	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-284	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-285	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-286	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene | *CH2Cl2 = methylene chloride* | *t12DCE = trans-1,2-dichloroethene*
11DCA = 1,1-dichloroethane | *c12DCE = cis-1,2-dichloroethene* | *CHCl3 = chloroform*
111TCA = 1,1,1-trichloroethane | *CCl4 = carbon tetrachloride* | *TCE = trichloroethene*
112TCA = 1,1,2-trichloroethane | *PCE = tetrachloroethene*

* *11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-287	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-288	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-289	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-290	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-291	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-292	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-293	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-294	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-295	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-296	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-297	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-298	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-299	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-300	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-300D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
SG-301	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-302	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-303	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-304	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-305	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-306	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-307	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-308	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-309	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-310	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-311	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-312	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-313	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-314	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-315	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene
CH2Cl2 = methylene chloride
t12DCE = trans-1,2-dichloroethene
11DCA = 1,1-dichloroethane
c12DCE = cis-1,2-dichloroethene
CHCl3 = chloroform
111TCA = 1,1,1-trichloroethane
CCl4 = carbon tetrachloride
TCE = trichloroethene
112TCA = 1,1,2-trichloroethane
PCE = tetrachloroethene

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-316	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-317	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-318	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-319	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-320	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-320D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-321	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-322	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-323	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-324	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-325	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-326	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-327	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-328	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-329	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-330	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-331	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-332	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-333	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-334	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-335	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-336	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-337	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-338	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-339	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-340	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-340D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-341	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-342	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-343	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene
11DCA = 1,1-dichloroethane
111TCA = 1,1,1-trichloroethane
112TCA = 1,1,2-trichloroethane
CH2Cl2 = methylene chloride
c12DCE = cis-1,2-dichloroethene
CCl4 = carbon tetrachloride
PCE = tetrachloroethene
t12DCE = trans-1,2-dichloroethene
CHCl3 = chloroform
TCE = trichloroethene

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.
SG-344	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-345	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-346	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-347	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-348	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-349	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-350	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-351	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-352	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-353	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-354	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-355	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-356	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-357	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-358	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	[illegible]
SG-359	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-360	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-360D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-361	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-363	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-364	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-365	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-366	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.
SG-367	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
SG-368	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
SG-369	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
SG-370	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
SG-371	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
SG-372	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
SG-373	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1

11DCE = 1,1-dichloroethene
11DCA = 1,1-dichloroethane
111TCA = 1,1,1-trichloroethane
112TCA = 1,1,2-trichloroethane
CH2Cl2 = methylene chloride
c12DCE = cis-1,2-dichloroethene
CCl4 = carbon tetrachloride
PCE = tetrachloroethene
t12DCE = trans-1,2-dichloroethene
CHCl3 = chloroform
TCE = trichloroethene

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-374	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-375	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-376	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-377	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-378	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-379	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-666	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-667	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-668	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-669	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-670	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-671	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-672	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-673	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-674	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-675	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-676	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-677	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-678	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-679	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-680	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-680D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-681	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-682	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-683	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-684	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-685	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-686	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-687	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-688	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene
11DCA = 1,1-dichloroethane
111TCA = 1,1,1-trichloroethane
112TCA = 1,1,2-trichloroethane
CH2Cl2 = methylene chloride
c12DCE = cis-1,2-dichloroethene
CCl4 = carbon tetrachloride
PCE = tetrachloroethene
t12DCE = trans-1,2-dichloroethene
CHCl3 = chloroform
TCE = trichloroethene

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-689	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-690	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-691	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-692	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-693	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-694	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-695	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-696	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-697	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-698	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-699	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-700	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-700D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-701	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-702	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	[illegible]
SG-703	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-704	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-705	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-706	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-707	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-708	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-709	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-710	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-711	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-712	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-713	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-714	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-715	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-716	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-717	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene
CH2Cl2 = methylene chloride
t12DCE = trans-1,2-dichloroethene
11DCA = 1,1-dichloroethane
c12DCE = cis-1,2-dichloroethene
CHCl3 = chloroform
111TCA = 1,1,1-trichloroethane
CCl4 = carbon tetrachloride
TCE = trichloroethene
112TCA = 1,1,2-trichloroethane
PCE = tetrachloroethene

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-718	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-719	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-720	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-720D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-721	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-722	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-723	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-724	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-725	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-726	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-727	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-728	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-729	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-730	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-732	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-733	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-734	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-735	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-736	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-737	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-738	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-739	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-740	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-740D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-741	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-742	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-743	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-744	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-745	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-746	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene — *CH2Cl2 = methylene chloride* — *t12DCE = trans-1,2-dichloroethene*
11DCA = 1,1-dichloroethane — *c12DCE = cis-1,2-dichloroethene* — *CHCl3 = chloroform*
111TCA = 1,1,1-trichloroethane — *CCl4 = carbon tetrachloride* — *TCE = trichloroethene*
112TCA = 1,1,2-trichloroethane — *PCE = tetrachloroethene*

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-747	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-748	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-749	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-750	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-751	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-752	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-753	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-754	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-755	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-756	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-757	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-758	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-759	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-760	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-760D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	[illegible]
SG-761	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-762	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-763	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-764	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-765	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-766	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-767	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-768	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-769	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-770	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-771	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-772	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-773	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-774	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-775	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene — *CH2Cl2 = methylene chloride* — *t12DCE = trans-1,2-dichloroethene*

11DCA = 1,1-dichloroethane — *c12DCE = cis-1,2-dichloroethene* — *CHCl3 = chloroform*

111TCA = 1,1,1-trichloroethane — *CCl4 = carbon tetrachloride* — *TCE = trichloroethene*

112TCA = 1,1,2-trichloroethane — *PCE = tetrachloroethene*

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-776	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-777	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-778	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-779	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-780	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-780D	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-781	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-782	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-783	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-784	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-785	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-786	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-787	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-788	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-789	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-790	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-791	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
FIELD CONTROL SAMPLES											
B-05	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
B-06	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
TB-04	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
TB-05	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
LABORATORY DUPLICATE ANALYSIS											
SG-207	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-207R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-217	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-217R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene
CH2Cl2 = methylene chloride
t12DCE = trans-1,2-dichloroethene
11DCA = 1,1-dichloroethane
c12DCE = cis-1,2-dichloroethene
CHCl3 = chloroform
111TCA = 1,1,1-trichloroethane
CCl4 = carbon tetrachloride
TCE = trichloroethene
112TCA = 1,1,2-trichloroethane
PCE = tetrachloroethene

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-225	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-225R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-235	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-235R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-244	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-244R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-254	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-254R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-267	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-267R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-273	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-273R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	[illegible]
SG-287	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-287R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-297	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-297R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-310	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-310R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-321	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-321R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-331	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-331R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-341	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-341R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene | *CH2Cl2 = methylene chloride* | *t12DCE = trans-1,2-dichloroethene*
11DCA = 1,1-dichloroethane | *c12DCE = cis-1,2-dichloroethene* | *CHCl3 = chloroform*
111TCA = 1,1,1-trichloroethane | *CCl4 = carbon tetrachloride* | *TCE = trichloroethene*
112TCA = 1,1,2-trichloroethane | *PCE = tetrachloroethene*

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-351	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-351R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-365	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-365R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-377	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-377R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-669	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-669R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-670	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-670R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-688	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-688R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-689	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-689R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-705	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-705R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-715	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-715R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-724	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-724R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-733	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-733R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-740	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-740R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene | *CH2Cl2 = methylene chloride* | *t12DCE = trans-1,2-dichloroethene*
11DCA = 1,1-dichloroethane | *c12DCE = cis-1,2-dichloroethene* | *CHCl3 = chloroform*
111TCA = 1,1,1-trichloroethane | *CCl4 = carbon tetrachloride* | *TCE = trichloroethene*
112TCA = 1,1,2-trichloroethane | *PCE = tetrachloroethene*

* *11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-760	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-760R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-770	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-770R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
B-05	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
B-05R	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

LABORATORY BLANKS

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
SG-207B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-217B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-225B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-235B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-244B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	[illegible]
SG-254B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	[illegible]
SG-267B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-273B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-287B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-297B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-310B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-321B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-331B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-341B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-351B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-365B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-377B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-669B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-670B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-688B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-689B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-705B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-715B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-724B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-733B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene
CH2Cl2 = methylene chloride
t12DCE = trans-1,2-dichloroethene
11DCA = 1,1-dichloroethane
c12DCE = cis-1,2-dichloroethene
CHCl3 = chloroform
111TCA = 1,1,1-trichloroethane
CCl4 = carbon tetrachloride
TCE = trichloroethene
112TCA = 1,1,2-trichloroethane
PCE = tetrachloroethene

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE*	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4*	TCE	112TCA	PCE
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SG-740B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-760B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SG-770B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
B-05B	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene   *CH2Cl2 = methylene chloride*   *t12DCE = trans-1,2-dichloroethene*

11DCA = 1,1-dichloroethane   *c12DCE = cis-1,2-dichloroethene*   *CHCl3 = chloroform*

111TCA = 1,1,1-trichloroethane   *CCl4 = carbon tetrachloride*   *TCE = trichloroethene*

112TCA = 1,1,2-trichloroethane   *PCE = tetrachloroethene*

** 11DCE/TCTFA and CCl4/12DCA are co-eluting pairs and are reported in concentrations of 11DCE and CCl4, respectively.*

FIELD PROCEDURES

Prior to the start of each day's sampling activities and between each sample location, the following decontamination procedure was carried out: hand auger bits were decontaminated by first scrubbing with Liquinox (a biodegradable, laboratory grade detergent) and potable water and rinsing with potable water. The bits were then rinsed once with de-ionized water, once with pesticide-grade isopropyl alcohol and twice more with deionized water.

A hole was made through pavement, where necessary, using a hammer drill with a 2-inch diameter, carbide-tipped bit. The boring was advanced to a depth of 2 to 3 feet using a hand auger. The passive sampling vial (with a gas permeable membrane sealing its open end) was taken from its sealed aluminum bag and placed membrane down into a holding device made of PVC material. (The holding device protects the vial and prevents the hole from collapsing.) The holding device was inserted into the hole and the surface sealed off with aluminum foil wadding and a thin cap of hydraulic cement.

The passive sampling vials were left in the ground for 3 days to allow equilibration with surrounding soil vapors. Following retrieval of the sample vial, a cap and teflon-faced butyl rubber septum were placed on the vial and crimped to form a seal. Prior to capping, the vials were maintained in a membrane down position. The vials were then packaged, labeled, and stored for laboratory analysis. All sampling holes were backfilled with bentonite and surfaces repaired with like material upon completion of the sampling.

ABT002 SAMPLE #	ABB GRID COORDINATES	DATE/TIME INSTALLED ,	DATE/TIME RETRIEVED
SG-201	N 2750 E 2150	0835 4/21/95	4/24/95 0940
SG-202	N 2800 E 2150	0830 4/21	4-24 0941
SG-203	N 2850 E 2150	0835 4/21	4-24 0943
SG-204	N 2900 E 2150	0839 4/21	4-24 0945
SG-205	N 2950 E 2150	0843 4/21	4-24 0946
SG-206	N 3000 E 2150	0846 4/21	4-24 0947
SG-207	N 3050 E 2150	0849 4/21	4-24 0950
SG-208	N 3100 E 2150	0854 4/21	4-24 0951
SG-209	N 3150 E 2150	0900 4/21	4-24 0952
SG-210	N 3200 E 2150	0904 4/21	4-24 0953
SG-211	N 3250 E 2150	0909 4/21	4-24 0956
SG-212	N 3300 E 2150	0910 4/21	4-24 0959
SG-213	N 3350 E 2150	0915 4/21	4-24 1000
SG-214	N 3400 E 2150	0920 4/21	4-24 1002
SG-215	N 3450 E 2150	0925 4/21	4-24 1003
SG-216	N 3500 E 2150	1051 4/21	4-24 1004
SG-217	N 3550 E 2150	1054 4/21	4-24 1006
SG-218	N 3550 E 2100	1100 4/21	4-24 1008
SG 219	N 3500 E 2100	1104 4/21	4-24 1009
SG 220	N 3450 E 2100	1106 4/21	4-24 1010
SG 220D	N 3450 E 2100	1110 4/21	4-24 1011
SG 221	N 3400 E 2100	1107 4/21	4-24 1012
SG 222	N 3350 E 2100	1114 4/21	4-24 1013
SG 223	N 3300 E 2100	1117 4/21	4-24 1015
SG 224	N 3250 E 2100	1120 4/21	4-24 1016
SG 225	N 3200 E 2100	1124 4/21	4-24 1017
SG 226	N 3150 E 2100	1127 4/21	4-24 1020
SG 227	N 3100 E 2100	1130 4/21	4-24 1021
SG 228	N 3050 E 2100	1131 4/21	4-24 1022
SG 229	N 3000 E 2100	1133 4/21	4-24 1023
SG 230	N 2950 E 2100	1136 4/21	4-24 1024
SG 231	N 2900 E 2100	1140 4/21	4-24 1025
SG 1'c 232	N 2850 E 2100	1142 4/21	4-24 1027
SG 233	N 2800 E 2100	1145 4/21	4-24 1028
SG 234	N 2750 E 2100	1148 4/21	4-24 1030
SG 235	N 2750 E 2200	1156 4/21	4-24 1032
SG 236	N 2800 E 2200	1200 4/21	4-24 1033
SG 237	N 2850 E 2200	1203 4/21	4-24 1034
SG 238	N 2900 E 2200	1205 4/21	4-24 1036
SG 239	N 2950 E 220	1207 4/21	4-24 1040
SG 240	N 3000 E 2200	1209 4/21	4-24 1041
SG 240D	" "	1210 4/21	4-24 1042

ABT002 SAMPLE #	ABB GRID COORDINATES	DATE/TIME INSTALLED	DATE/TIME RETRIEVED
SG-241	N 3050 E [illegible]	1215 4/21	4-24 [illegible]
SG-242	N 3100 E 2200	1217 4/21	4-24 1044
SG-243	N 3150 E 2200	1221 4/21	4-24 1045
SG-244	N 3200 E 2200	1225 4/21	4-24 1046
SG-245	N 3250 E 2210	1228 4/21	4-24 1048
SG-246	N 3300 E 2210	1231 4/21	4-24 1050
SG-247	N 3350 E 2210	1232 4/21	4-24 1051
SG-248	N 3400 E 2210	1409 4/21	4-24 1052
SG-249	N 3450 E 2210	1412 4/21	4-24 1053
SG-250	N 3500 E 2210	1418 4/21	4-24 1054
SG-251	N 3550 E 2210	1420 4/21	4-24 1055
SG-252	N 3550 E 2250	1422 4/21	4-24 1056
SG-253	N 3500 E 2250	1424 4/21	4-24 1057
SG-254	N 3450 E 2250	1428 4/21	4-24 1058
SG-255	N 3400 E 2250	1430 4/21	4-24 1059
SG-256	N 3350 E 2250	1432 4/21	4-24 1100
SG-257	N 3300 E 2250	1434 4/21	4-24 1101
SG-258	N 3250 E 2250	1436 4/21	4-24 1102
SG-259	N 3200 E 2250	1438 4/21	4-24 1103
SG-260	N 3150 E 2250	1440 4/21	4-24 1104
SG-260D	N 3150 E 2250	1440 4/21	4-24 1104
SG-261	N 3100 E 2250	1445 4/21	4-24 1105
SG-262	N 3050 E 2250	1447 4/21	4-24 1106
SG-263	N 3000 E 2250	1449 4/21	4-24 1107
SG-264	N 2950 E 2250	1451 4/21	4-24 1108
SG-265	N 2900 E 2250	1453 4/21	4-24 1109
SG-266	N 2850 E 2250	1455 4/21	4-24 1110
SG-267	N 2800 E 2250	1457 4/21	4-24 1112
SG-268	N 2750 E 2250	1459 4/21	4-24 1113
SG-269	N 2750 E 2350	1527 4/21	4-24 1114
SG-270	N 2800 E 2350	1529 4/21	4-24 1115
SG-271	N 2850 E 2350	1531 4/21	4-24 1116
SG-272	N 2900 E 2350	1533 4/21	4-24 1118
SG-273	N 2950 E 2350	1535 4/21	4-24 1119
SG-274	N 3000 E 2350	1537 4/21	4-24 1120
SG-275	N 3050 E 2350	1539 4/21	4-24 1121
SG-276	N 3100 E 2350	1541 4/21	4-24 1122
SG-277	N 3150 E 2350	1543 4/21	4-24 1123
SG-278	N 3200 E 2350	1545 4/21	4-24 1125

ABT002 SAMPLE #	ABB GRID COORDINATES		DATE/TIME INSTALLED		DATE/TIME RETRIEVED	
SG-279	3000 N	3100S	1534	4/22	4-25	1231
SG-280	3000 N	3050S	1537	4/22	4-25	1233
SG-280D	"	"	1627	4/22	4-25	1233
SG-281	3000N	3000N	1540	4/22	4-25	1234
SG-282	3050N	3100S	1544	4/22	4-25	1229
SG-283	3050N	3150S	1547	4/22	4-25	1228
SG-284	3100N	3150S	1550	4/22	4-25	1227
SG-285	3100N	3100S	1554	4/22	4-25	1226
SG-286	3100N	3050S	1557	4/22	4-25	1225
SG-287	3100N	3000S	1600	4/22	4-25	1224
SG-288	3100N	2950S	1603	4/22	4-25	1223
SG-289	3100N	2900S	1606	4/22	4-25	1222
SG-290	3150N	2900S	1609	4/22	4-25	1216
SG-291	3150N	2950S	1612	4/22	4-25	1215
SG-292	3150N	3000S	1615	4/22	4-25	1214
SG-293	3150N	3050S	1618	4/22	4-25	1213
SG-294	3150N	3100S	1621	4/22	4-25	1212
SG-295	3200N	3150S	1624	4/22	4-25	1211
SG-296	3200N	3150S	1630	4/22	4-25	1210
SG-297	3200N	3100S	1633	4/22	4-25	1209
SG-298	3200N	3050S	1636	4/22	4-25	1208
SG-299	3200N	3000S	1639	4/22	4-25	1207
SG-300	3200N	2950S	1642	4/22	4-25	1206
SG-300D	"	"	1645	4/22	4-25	1206
SG-301	3200N	2900S	1648	4/22	4-25	1205

ABT002 SAMPLE #	ABB GRID COORDINATES		DATE/TIME INSTALLED		DATE/TIME RETRIEVED	
SG-302	2850N	2550E	0729	4/23/95	4-26	0914
SG-303	2900N	2550E	0732	4.23	4-26	0915
SG-304	2950N	2550E	0735	4.23	4-26	0916
SG-305	3000N	2550E	0737	4.23	4-26	0917
SG-306	3050N	2550E	0740	4.23	4-26	0918
SG-307	3100N	2550E	0742	4.23	4-26	0919
SG-308	3150N	2550E	0744	4.23	4-26	0920
SG-309	3200N	2550E	0747	4.23	4-26	0923
SG-310	3250N	2550E	0749	4.23	4-26	0924
SG-311	3300N	2550E	0751	4.23	4-26	0926
SG-312	3350N	2550E	0753	4.23	4-26	0928
SG-313	3400N	2550E	0755	4.23	4-26	0930
SG-314	3450N	2550E	0757	4.23	4-26	0931
SG-315	3500N	2550E	0800	4.23	4-26	0932
SG-316	3550N	2550E	0802	4.23	4-26	0933
SG-317	3550N	2600E	0805	4.23	4-26	0934
SG-318	3500N	2600E	0807	4.23	4-26	0935
SG-319	3450N	2600E	0809	4.23	4-26	0936
SG-320	3400N	2600E	0811	4.23	4-26	0937
SG-320D	"	"	0814	4.23	4-26	0938
SG-321	3350N	2600E	0816	4.23	4-26	0939
SG-322	3300N	2600E	0818	4.23	4-26	0940
SG-323	3250N	2600E	0821	4.23	4-26	0941
SG-324	3200N	2600E	0823	4.23	4-26	0942
SG-325	3150N	2600E	0825	4.23	4-26	0943
SG-326	3100N	2600E	0827	4.23	4-26	0944
SG-327	3050N	2600E	0830	4.23	4-26	0945
SG-328	3000N	2600E	0832	4.23	4-26	0946
SG-329	2950N	2600E	0835	4.23	4-26	0947
SG-330	2900N	2600E	0837	4.23	4-26	0948
SG-331	2850N	2600E	0839	4.23	4-26	0949
SG-332	2850N	2650E	0842	4.23	4-26	0950
SG-333	2900N	2650E	0845	4.23	4.26	0955
SG-334	2950N	2650E	0847	4.23	4.26	0957
SG-335	3000N	2650E	0850	4.23	4.26	0959
SG-336	3050N	2650E	0853	4.23	4-26	1001
SG-337	3100N	2650E	0855	4.23	4-26	1002
SG-338	3150N	2650E	0858	4.23	4-26	1004
SG-339	3200N	2650E	0901	4.23	4-26	1006
SG-340	3250N	2650E	0904	4.23	4-26	1007
SG-340D	"	"	0906	4.23	4-26	1007
SG-341	3300N	2650E	0909	4.23	4-26	1008

ABT002	ABB GRID	DATE/TIME	DATE/TIME
SAMPLE #	COORDINATES	INSTALLED	RETRIEVED
SG-342	3350N 2650E	0911 4/23/95	4-26 1010
SG-343	3400N 2650E	0914 4.23	4-26 1012
SG-344	3450N 2650E	0917 4.23	4-26 1014
SG-345	3500N 2650E	0919 4.23	4-26 1015
SG-346	3550N 2650E	0922 4.23	4-26 1016
SG-347	3550N 2700E	0925 4.23	4-26 1018
SG-348	3500N 2700E	0928 4.23	4-26 1020
SG-349	3450N 2700E	0930 4.23	4-26 1022
SG-350	3400N 2700E	0933 4.23	4-26 1025
SG-351	3350N 2700E	0935 4.23	4-26 1028
SG-352	3300N 2700E	0938 4.23	4-26 1029
SG-353	3250N 2700E	0940 4.23	4-26 1030
SG-354	3200N 2700E	0942 4.23	4-26 1031
SG-355	3150N 2700E	0945 4.23	4-26 1032
SG-356	3100N 2700E	0947 4.23	4-26 1033
SG-357	3050N 2700E	0950 4.23	4-26 1034
SG-258	300N 2700E	0952 4.23	4-26 1035
SG-359	2950N 2700E	0955 4.23	4-26 1036
SG-360	2900N 27000	0958 4-23	4-26 1037
SG-360 D	" "	1002 4.23	4-26 1038
SG-361	2850N 2700E	1004 4.23	4-26 1039
SG-362				REFUSAL
SG-363	2850N 2750E	1010 4.23	4-26 1041
SG-364	2900N 2750E	1012 4.23	4-26 1042
SG-365	2950N 2750E	1014 4.23	4-26 1043
SG-366	3000N 2750E	1017 4.23	4-26 1044
SG-367	3050N 2750E	1019 4.23	4-26 1045
SG-368	3100N 2750E	1021 4.23	4-26 1046
SG-369	3150N 2750E	1023 4.23	4-26 1047
SG-370	3200N 2750E	1026 4.23	4-26 1048
SG-371	3250N 2750E	1029 4.23	4-26 1049
SG-372	3300N 2750E	1031 4.23	4-26 1050
SG-373	3350N 2750E	1033 4.23	4-26 1051
SG-374	3400N 2750E	1035 4.23	4-26 1052
SG-375	3450N 2750E	1037 4.23	4-26 1055
SG-376	3500N 2750E	1039 4.23	4-26 1056
SG-377	3550N 2750E	1041 4.23	4-26 1057
SG-378	2900N 2850E	1043 4.23	4-26 1100
SG-379	2950N 3000E	1053 4/23/95	4-26 1102

ABT002

ABT002 SAMPLE #	ABB GRID COORDINATES	DATE/TIME INSTALLED		DATE/TIME RETRIEVED	
SG 666	3550 N, 2300E	4/21/95	1417	4/24	958
SG 667	3500N, 2300E		1419		1001
SG 668	3450N 2300E		1422		1005
SG 669	3400 N, 2300E		1424		1009
SG 670	3350 N 2300E		1425		1011
SG 671	3300 N 2300E		1427		1014
SG 672	3250 N, 2300E		1428		1016
SG 673	3200 N, 2300E		1430		1017
SG 674	3150 N 2300E		1431		1020
SG 675	3100 N 2300E		1433		1021
SG 676	3050 N 2300E		1438		1022
SG 677	3000 N 2300E		1439		1025
SG 678	2950 N, 2300E		1441		1027
SG 679	2900 N 2300E		1450		1030
SG 680	2850 N 2300E		1453		1032
SG 680-D	2850 N 2300E		1455		1033
SG 681	2800 N 2300E		1458		1034
SG 682	2750 N, 2300E		1500		1035
SG 683	2750 N, 2400E		1525		1040
SG 684	2800 N, 2400E		1526		1042
SG 685	2850 N, 2400E		1528		1044
SG 686	2900 N 2400E		1530		1045
SG 687	2950 N, 2400E		1532		1046
SG 688	3000 N, 2400E		1534		1050
SG 689	3050 N, 2400E		1535		1051
SG 690	3100 N, 2400E		1538		1053
SG 691	3150 N, 2400E		1540		1055
SG 692	3200 N, 2400E		1541		1059
SG 693	3250 N, 2350E	4/22/95	0730	4-25	1016
SG 694	3300 N, 2350E		0731	4-25	1017
SG 695	3350 N, 2350E		0733	4-25	1018
SG 696	3400 N, 2350E		0735	4-25	1019
SG 697	3450 N 2350E		0736	4-25	1020
SG 698	3500 N, 2350E		0738	4-25	1021

ABT002 SAMPLE #	ABB GRID COORDINATES	DATE/TIME INSTALLED	DATE/TIME RETRIEVED
SG 699	2350 E, 3550 N	4/22/95 0740	4-25 1021
SG 700	2400 E, 3550 N	0742	4-25 1008
SG 700 D	2400, 3550 N	0742	4-25 1008
SG 701	2400 E, 3500 N	0744	4-25 1009
SG 702	2400 E 3450 N	0746	4-25 1010
SG 703	2400 E 3400 N	748	4-25 1011
SG 704	2400 E 3350 N	750	4-25 1012
SG 705	2400 E 3300 N	755	4-25 1013
SG 706	2400 E 3250 N	757	4-25 1014
SG 707	~~2400 E~~ ~~3200 N~~ 2450 E 3550 N	759	4-25 1024
SG 708	~~2400 E~~ ~~3150 N~~ 2450 E 3500 N	800	4-25 1005
SG 709	ADJ ~~2400 E~~ ~~3100 N~~ 2450 E 3450 N	801	4-25 1004
SG 710	~~2400 E~~ ~~3050 N~~ 2450 E 3400 N	0802	4-25 1003
SG 711	~~2400 E~~ ~~3000 N~~ 2450 E 3350 N	804	4-25 1002
SG 712	~~2400 E~~ 2450 E 3300 N	806	4-25 1001
SG 713	2450 E ~~3200 N~~ 3250 N	808	4-25 1000
SG 714	2450 E ~~3150 N~~ 3200 N	810	4-25 0959
SG 715	2450 E ~~3100 N~~ 3150 N	820	4-25 0958
SG 716	2450 E ~~3050 N~~ 3100 N	822	4-25 0957
SG 717	2450 E ~~3000 N~~ 3050 N	824	4-25 0956
SG 718	2450 E ~~2950 N~~ 3000 N	826	4-25 0955
SG 719	2450 E 2950 N	828	4-25 0954
SG 720	2450 E 2900 N	0830	4/25 0952
SG 720-D	2450 E ~~[illegible]~~ 2900 N	830	4/25 0952
SG 721	2450 E 2850 N	832	4/25 0951
SG 722	2450 E 2800 N	834	4/25 0950
SG 723	2450 E 2750 N	835	4/25 0949
SG 724	2500 E 2750 N	850	4/25 1058
SG 725	2550 E 2750 N	852	4-25 1059
SG 726	2600 E 2750 N	853	4-25 1100
SG 727	2650 E 2750 N	855	4-25 1101
SG 728	2700 E 2750 N	857	4-25 1102
SG 729	2700 E 2800 N	859	4-25 1104
SG 730	2650 E 2800 N	900	4-25 1105
* SG 731	2600 E 2800 N	XXXXXXXX	XXX XXXX
SG 732	2550 E 2800 N	910	4-25 1106
SG 733	2500 E 2800 N	914	4-25 1056
SG 734	2500 E 3550 N	1207	4-25 1024
SG 735	2500 E 3500 N	1215	4-25 1025
SG 736	2500 E 3450 N	1225	4-25 1031
SG 737	2500 E 3400 N	1230	4-25 1032
SG 738	2500 E 3350 N	1235	4-25 1033

* HIT H_2O SPRINKLER LINE @ SG 731

ABT002 SAMPLE #	ABB GRID COORDINATES	DATE/TIME INSTALLED	DATE/TIME RETRIEVED
SG 739	2500 E 3300 N	4/22/95 1239	4/25 1034
SG 740	2500 E 3250 N		4-25 1036
SG 740 D	2500 E 3250 N		4-25 1036
SG 741	2500 E 3200 N		4-25 1038
SG 742	2500 E 3150 N		4-25 1040
SG 743	2500 E 3100 N		4-25 1041
SG 744	2500 E 3050 N		4-25 1042
SG 745	2500 E 3000 N		4-25 1043
SG 746	2500 E 2950 N		4-25 1044
SG 747	2500 E 2900 N		4-25 1045
SG 748	2500 E 2850 N		4-25 1046
SG 749	2800 E 2850 N		4-25 1119
SG 750	2800 E 2900 N		4-25 1120
SG 751	2800 E 2950 N		4-25 1121
SG 752	2800 E 3000 N		4-25 1122
SG 753	2800 E 3050 N		4-25 1124
SG 754	2800 E 3100 N		4-25 1125
SG 755	2800 E 3150 N		4-25 1126
SG 756	2800 E 3200 N		4-25 1127
SG 757	2800 E 3250 N		4-25 1127
SG 758	2800 E 3300 N		4-25 1128
SG 759	2800 E 3350 N		4-25 1129
SG 760	2800 E 3400 N		4-25 1130
SG 760 D	2800 E 3400 N		4-25 1130
SG 761	2800 E 3450 N		4-25 1131
SG 762	2800 E 3500 N		4-25 1132
SG 763	2800 E 3550 N		4-25 1133
SG 764	3000 E 3500 N		4-25 1141
SG 765	3000 E 3450 N		4-25 1142
SG 766	3050 E 3500 N		4-25 1140
SG 767	3050 E 3450 N		4-25 1143
SG 768	3100 E 3500 N		4-25 1139
SG 769	3100 E 3450 N		4-25 1144
SG 770	3150 E 3500 N		4-25 1138
SG 771	3150 E 3450 N		4-25 1145
SG 772	3100 E 3400 N		4-25 1147
SG 773	3150 E 3400 N		4-25 1146
SG 774	2900 E 3350 N		4-25 1155
SG 775	2950 E 3350 N		4-25 1154
SG 776	3000 E 3350 N		4-25 1153
SG ~~775~~ 777	3050 E 3350 N		4-25 1152
SG ~~776~~ 778	3100 E 3350 N		4-25 1151

ABT002 SAMPLE #	ABB GRID COORDINATES	DATE/TIME INSTALLED	DATE/TIME RETRIEVED
SG-779	3150E 3350N	4/22/95	4-25 1150
SG-780	2900E 3300N		4-25 1149
SG-780-D	[illegible] 3300N		4-25 1148
SG-78[illegible]	2900E 3300N		[illegible] 1155
SG-781	3000E 3300N		4-25 1156
SG-7[illegible]	3050E 3300N		4-25 1153
SG-784	3100E 3300N		4-25 1157
SG-785	3150E 3300N		4-25 1158
SG-786	2900E 3250N		4-25 1159
SG-78[illegible]	2950E 3250N		[illegible] [illegible]
SG-788	3000E 3250N		4-25 [illegible]
SG-789	3050E 3250N		4-25 1203
SG-790	3100E 3250N		4-25 1202
SG-791	3150E 3250N		4-25 1201

LABORATORY PROCEDURES

The analytical equipment was calibrated using a 3-point instrument-response curve and injection of known concentrations of the target analytes. Retention times of the standards were used to identify the peaks in the chromatograms of the field samples, and their response factors were used to calculate the analyte concentrations.

Total FID Volatiles values were generated by summing the areas of all integrated chromatogram peaks and calculated using the instrument response factor for naphtha. Injection peaks, which also contain the light hydrocarbon methane, were excluded to avoid the skewing of Total FID Volatiles values due to injection disturbances and biogenic methane. For samples with low hydrocarbon concentrations, the calculated Total FID Volatiles concentration is occasionally lower than the sum of the individual analytes. This is because the response factor used for the Total FID Volatiles calculation is a constant, whereas the individual analyte response factors are compound specific. It is important to understand that the Total FID Volatiles levels reported are relative, not absolute, values.

DETECTABILITY & TERMINOLOGY

Detectability

The soil gas survey data presented in this report are the result of precise sampling and measurement of contaminant concentrations in the vadose zone. Analyte detection at a particular location is representative of vapor, dissolved, and/or liquid phase contamination at that location. The presence of detectable levels of target analytes in the vadose zone is dependent upon several factors, including the presence of vapor-phase hydrocarbons or dissolved or liquid concentrations adequate to facilitate volatilization into the unsaturated zone.

Terminology

In order to prevent misunderstanding of certain terms used in **TARGET**'s reports, the following clarifications are offered:

Analyte refers to any of the hydrocarbons standardized for quantification in the chromatographic analysis.

Anomaly refers to an area where hydrocarbons were measured in excess of what would normally be considered "natural" or "background" levels.

Elevated and **significant** are used to describe concentrations of analytes which indicate the existence of a potential problem in the soil or ground water.

Feature is used in reference to a discernible pattern in the contoured data. It denotes a contour form rather than a definite or separate chemical occurrence.

Indicates is used when evidence dictates a unique conclusion. **Suggests** is used when several explanations of certain evidence are possible, but one in particular seems more likely. As a result, "indicates" carries a higher degree of confidence in a conclusion than does "suggests."

Occurrence is used to indicate an area where chemical compounds are present in sufficient concentrations to be detected by the analysis of soil vapors. The term is not indicative of any specific mode of occurrence (vapor, dissolved, etc.), and does not necessarily indicate or suggest the presence of "free product" or "phase-separated hydrocarbons."

Reporting Limit refers to the minimum concentration reported for each analyte.

Vadose zone represents the unsaturated zone between the ground water table and the ground surface.

The terms "low", "moderate" and "high" levels, when applied to Total FID Volatile petroleum hydrocarbons, are relative terms based on **TARGET**'s analysis of thousands of soil gas samples from hundreds of sites. Less than 100 μg/l can be considered very low. Levels between 0 and 1000 μg/l can be considered typical "background" levels often observed at fuel handling facilities. "Moderate" levels include concentrations in the range of 25,000 to 50,000 μg/l. Levels greater than 100,000 μg/l are deemed "high", while those greater than 750,000 μg/l are considered to be very high.

The same terms when applied to chlorinated hydrocarbons refer to much lower levels. This is partially due to the fact that individual analytes rather than chlorinated "totals" are being discussed, and partially due to the generally more serious nature of contamination by these compounds. Concentrations less than 1-2 μg/l are considered relatively low and those around 10-20 μg/l are considered moderate. High values include levels greater than 100 μg/l, while concentrations over 1000 μg/l are considered extremely high.

APPENDIX D-1
PASSIVE SOIL GAS/HAND AUGER SURVEY
OU 1, NORTH GRINDER LANDFILL

SG NO.	X	Y	EAST	NORTH	FID (PPM)	DEPTH (IN)	REMARKS
201	2150	2750	547268.5	1541842.5	0	36	
202	2150	2800	547268.5	1541892.5	0	36	
203	2150	2850	547268.5	1541942.5	0	36	
204	2150	2900	547268.5	1541992.5	0	36	
205	2150	2950	547268.5	1542042.5	0	36	
206	2150	3000	547268.5	1542092.5	0	36	
207	2150	3050	547268.5	1542142.5	35	36	
208	2150	3100	547268.5	1542192.5	0	36	
209	2150	3150	547268.5	1542242.5	0	36	
210	2150	3200	547268.5	1542292.5	0	36	
211	2150	3250	547268.5	1542342.5	0	36	
212	2150	3300	547268.5	1542392.5	0	36	
213	2150	3350	547268.5	1542442.5	0	36	
214	2150	3400	547268.5	1542492.5	0	36	
215	2150	3450	547268.5	1542542.5	0	36	
216	2150	3500	547268.5	1542592.5	0	36	
217	2150	3550	547268.5	1542642.5	0	36	
218	2100	3550	547218.5	1542642.5	0	36	
219	2100	3500	547218.5	1542592.5	0	36	
220	2100	3450	547218.5	1542542.5	0	36	
221	2100	3400	547218.5	1542492.5	0	36	
222	2100	3350	547218.5	1542442.5	0	36	
223	2100	3300	547218.5	1542392.5	0	36	
224	2100	3250	547218.5	1542342.5	0	36	
225	2100	3200	547218.5	1542292.5	0	36	
226	2100	3150	547218.5	1542242.5	0	36	
227	2100	3100	547218.5	1542192.5	10	36	
228	2100	3050	547218.5	1542142.5	0	36	
229	2100	3000	547218.5	1542092.5	0	36	
230	2100	2950	547218.5	1542042.5	0	36	
231	2100	2900	547218.5	1541992.5	0	36	
232	2100	2850	547218.5	1541942.5	0	36	
233	2100	2800	547218.5	1541892.5	0	36	
234	2100	2750	547218.5	1541842.5	0	36	
235	2200	2750	547318.5	1541842.5	0	24	
236	2200	2800	547318.5	1541892.5	0	24	
237	2200	2850	547318.5	1541942.5	0	24	
238	2200	2900	547318.5	1541992.5	0	24	
239	2200	2950	547318.5	1542042.5	0	24	
240	2200	3000	547318.5	1542092.5	0	24	
241	2200	3050	547318.5	1542142.5	0	24	
242	2200	3100	547318.5	1542192.5	2	18	hit plastic, metal, fabric
243	2200	3150	547318.5	1542242.5	0	24	
244	2200	3200	547318.5	1542292.5	0	24	hit foam, plastic
245	2210	3250	547328.5	1542342.5	0	24	trash: tar at 24"
246	2210	3300	547328.5	1542392.5	0	22	
247	2210	3350	547328.5	1542442.5	0	22	
248	2210	3400	547328.5	1542492.5	0	22	
249	2210	3450	547328.5	1542542.5	0	22	
250	2210	3500	547328.5	1542592.5	0	22	
251	2210	3550	547328.5	1542642.5	0	22	
252	2250	3550	547368.5	1542642.5	0	22	
253	2250	3500	547368.5	1542592.5	0	22	
254	2250	3450	547368.5	1542542.5	0	22	
255	2250	3400	547368.5	1542492.5	0	22	

NOTE: "Xs" and "Ys" are arbitrary grid coordinates; "EAST" and "NORTH" are State Grid Coordinates, Florida East Zone, NAD 83.

APPENDIX D-1
PASSIVE SOIL GAS/HAND AUGER SURVEY
OU 1, NORTH GRINDER LANDFILL

SG NO.	X	Y	EAST	NORTH	FID (PPM)	DEPTH (IN)	REMARKS
256	2250	3350	547368.5	1542442.5	0	22	
257	2250	3300	547368.5	1542392.5	0	22	
258	2250	3250	547368.5	1542342.5	0	22	
259	2250	3200	547368.5	1542292.5	0	22	
260	2250	3150	547368.5	1542242.5	0	22	22" = wood chips
261	2250	3100	547368.5	1542192.5	0	22	
262	2250	3050	547368.5	1542142.5	0	22	
263	2250	3000	547368.5	1542092.5	0	22	
264	2250	2950	547368.5	1542042.5	0	22	
265	2250	2900	547368.5	1541992.5	0	22	
266	2250	2850	547368.5	1541942.5	0	22	
267	2250	2800	547368.5	1541892.5	0	22	
268	2250	2750	547368.5	1541842.5	0	22	
269	2350	2750	547468.5	1541842.5	0	22	
270	2350	2800	547468.5	1541892.5	0	22	
271	2350	2850	547468.5	1541942.5	0	22	
272	2350	2900	547468.5	1541992.5	0	22	
273	2350	2950	547468.5	1542042.5	0	22	
274	2350	3000	547468.5	1542092.5	0	22	
275	2350	3050	547468.5	1542142.5	0	22	
276	2350	3100	547468.5	1542192.5	0	22	
277	2350	3150	547468.5	1542242.5	0	22	
278	2350	3200	547468.5	1542292.5	0	22	
279	3100	3000	548218.5	1542092.5	0	22	
280	3050	3000	548168.5	1542092.5	0	22	
281	3000	3000	548118.5	1542092.5	0	22	
282	3100	3050	548218.5	1542142.5	0	22	
283	3150	3050	548268.5	1542142.5	0	22	
284	3150	3100	548268.5	1542192.5	0	22	
285	3100	3100	548218.5	1542192.5	0	22	
286	3100	3050	548218.5	1542142.5	0	22	
287	3100	3000	548218.5	1542092.5	0	22	
288	3100	2950	548218.5	1542042.5	0	22	
289	3100	2900	548218.5	1541992.5	0	22	
290	2900	3150	548018.5	1542242.5	0	22	
291	2950	3150	548068.5	1542242.5	0	22	
292	3000	3150	548118.5	1542242.5	0	22	
293	3050	3150	548168.5	1542242.5	0	22	
294	3100	3150	548218.5	1542242.5	0	22	
295	3150	3150	548268.5	1542242.5	0	22	
296	3150	3200	548268.5	1542292.5	0	22	
297	3100	3200	548218.5	1542292.5	0	22	
298	3050	3200	548168.5	1542292.5	0	22	
299	3000	3200	548118.5	1542292.5	0	22	
300	2950	3200	548068.5	1542292.5	0	22	
301	2900	3200	548018.5	1542292.5	0	22	
302	2550	2850	547668.5	1541942.5	0	22	
303	2550	2900	547668.5	1541992.5	0	22	
304	2550	2950	547668.5	1542042.5	0	22	
305	2550	3000	547668.5	1542092.5	0	22	
306	2550	3050	547668.5	1542142.5	0	22	
307	2550	3100	547668.5	1542192.5	0	22	
308	2550	3150	547668.5	1542242.5	0	22	
309	2550	3200	547668.5	1542292.5	0	22	
310	2550	3250	547668.5	1542342.5	0	22	

NOTE: "Xs" and "Ys" are arbitrary grid coordinates; "EAST" and "NORTH" are State Grid Coordinates, Florida East Zone, NAD 83.

APPENDIX D-1
PASSIVE SOIL GAS/HAND AUGER SURVEY
OU 1, NORTH GRINDER LANDFILL

SG NO.	X	Y	EAST	NORTH	FID (PPM)	DEPTH (IN)	REMARKS
311	2550	3300	547668.5	1542392.5	10	22	
312	2550	3350	547668.5	1542442.5	0	22	
313	2550	3400	547668.5	1542492.5	0	22	
314	2550	3450	547668.5	1542542.5	0	22	
315	2550	3500	547668.5	1542592.5	0	22	
316	2550	3550	547668.5	1542642.5	0	22	
317	2600	3550	547718.5	1542642.5	0	22	
318	2600	3500	547718.5	1542592.5	3	22	
319	2600	3450	547718.5	1542542.5	0	22	
320	2600	3400	547718.5	1542492.5	0	22	
321	2600	3350	547718.5	1542442.5	0	22	
322	2600	3300	547718.5	1542392.5	0	22	
323	2600	3250	547718.5	1542342.5	0	22	
324	2600	3200	547718.5	1542292.5	15	22	
325	2600	3150	547718.5	1542242.5	0	22	refusal
326	2600	3100	547718.5	1542192.5	100	22	
327	2600	3050	547718.5	1542142.5	200	22	
328	2600	3000	547718.5	1542092.5	15	22	
329	2600	2950	547718.5	1542042.5	10	22	
330	2600	2900	547718.5	1541992.5	0	22	
331	2600	2850	547718.5	1541942.5	0	22	
332	2650	2850	547768.5	1541942.5	0	22	
333	2650	2900	547768.5	1541992.5	0	22	
334	2650	2950	547768.5	1542042.5	15	22	
335	2650	3000	547768.5	1542092.5	180	22	
336	2650	3050	547768.5	1542142.5	60	22	
337	2650	3100	547768.5	1542192.5	40	22	
338	2650	3150	547768.5	1542242.5	0	22	
339	2650	3200	547768.5	1542292.5	0	22	
340	2650	3250	547768.5	1542342.5	0	22	
341	2650	3300	547768.5	1542392.5	0	22	
342	2650	3350	547768.5	1542442.5	0	22	
343	2650	3400	547768.5	1542492.5	0	22	
344	2650	3450	547768.5	1542542.5	0	22	
345	2650	3500	547768.5	1542592.5	0	22	
346	2650	3550	547768.5	1542642.5	0	22	
347	2700	3550	547818.5	1542642.5	0	22	
348	2700	3500	547818.5	1542592.5	0	22	
349	2700	3450	547818.5	1542542.5	0	22	
350	2700	3400	547818.5	1542492.5	0	22	
351	2700	3350	547818.5	1542442.5	0	22	
352	2700	3300	547818.5	1542392.5	0	22	
353	2700	3250	547818.5	1542342.5	0	22	
354	2700	3200	547818.5	1542292.5	0	22	
355	2700	3150	547818.5	1542242.5	0	22	
356	2700	3100	547818.5	1542192.5	0	22	
357	2700	3050	547818.5	1542142.5	9	22	
358	2700	3000	547818.5	1542092.5	3	22	
359	2700	2950	547818.5	1542042.5	0	22	
360	2700	2900	547818.5	1541992.5	0	22	
361	2700	2850	547818.5	1541942.5	0	22	
362	2750	2800	547868.5	1541892.5	0	22	refusal
363	2750	2850	547868.5	1541942.5	0	22	
364	2750	2900	547868.5	1541992.5	0	22	
365	2750	2950	547868.5	1542042.5	0	22	

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APPENDIX D-1
PASSIVE SOIL GAS/HAND AUGER SURVEY
OU 1, NORTH GRINDER LANDFILL

SG NO.	X	Y	EAST	NORTH	FID (PPM)	DEPTH (IN)	REMARKS
366	2750	3000	547868.5	1542092.5	0	18	stop at 18", plastic
367	2750	3050	547868.5	1542142.5	0	22	
368	2750	3100	547868.5	1542192.5	0	22	
369	2750	3150	547868.5	1542242.5	0	22	
370	2750	3200	547868.5	1542292.5	0	22	
371	2750	3250	547868.5	1542342.5	0	22	debris at 22"
372	2750	3300	547868.5	1542392.5	0	22	
373	2750	3350	547868.5	1542442.5	0	22	
374	2750	3400	547868.5	1542492.5	0	22	
375	2750	3450	547868.5	1542542.5	0	22	
376	2750	3500	547868.5	1542592.5	0	22	
377	2750	3550	547868.5	1542642.5	0	22	
378	2850	2900	547968.5	1541992.5	0	22	
379	3000	2950	548118.5	1542042.5	0	22	
666	2300	3550	547418.5	1542642.5	0	22	
667	2300	3500	547418.5	1542592.5	0	22	
668	2300	3450	547418.5	1542542.5	0	22	
669	2300	3400	547418.5	1542492.5	0	22	
670	2300	3350	547418.5	1542442.5	0	22	
671	2300	3300	547418.5	1542392.5	0	22	
672	2300	3250	547418.5	1542342.5	0	22	
673	2300	3200	547418.5	1542292.5	0	22	
674	2300	3150	547418.5	1542242.5	0	22	
675	2300	3100	547418.5	1542192.5	0	22	
675	2300	3100	547418.5	1542192.5	0	22	
676	2300	3050	547418.5	1542142.5	0	22	
676	2300	3050	547418.5	1542142.5	0	22	
677	2300	3000	547418.5	1542092.5	0	22	
677	2300	3000	547418.5	1542092.5	0	22	
678	2300	2950	547418.5	1542042.5	0	22	
678	2300	2950	547418.5	1542042.5	0	22	
679	2300	2900	547418.5	1541992.5	0	22	
679	2300	2900	547418.5	1541992.5	0	22	
680	2300	2850	547418.5	1541942.5	0	22	
680	2300	2850	547418.5	1541942.5	0	22	
681	2300	2800	547418.5	1541892.5	0	22	
681	2300	2800	547418.5	1541892.5	0	22	
682	2300	2750	547418.5	1541842.5	0	22	
682	2300	2750	547418.5	1541842.5	0	22	
683	2400	2750	547518.5	1541842.5	0	22	
684	2400	2800	547518.5	1541892.5	0	22	
685	2400	2850	547518.5	1541942.5	0	22	
686	2400	2900	547518.5	1541992.5	0	22	
687	2400	2950	547518.5	1542042.5	0	22	
688	2400	3000	547518.5	1542092.5	0	22	
689	2400	3050	547518.5	1542142.5	0	22	
690	2400	3100	547518.5	1542192.5	0	22	
691	2400	3150	547518.5	1542242.5	0	22	
692	2400	3200	547518.5	1542292.5	0	22	
693	2350	3250	547468.5	1542342.5	0	22	
694	2350	3300	547468.5	1542392.5	0	22	
695	2350	3350	547468.5	1542442.5	0	22	
696	2350	3400	547468.5	1542492.5	0	22	
697	2350	3450	547468.5	1542542.5	0	22	
698	2350	3500	547468.5	1542592.5	0	22	

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APPENDIX D-1
PASSIVE SOIL GAS/HAND AUGER SURVEY
OU 1, NORTH GRINDER LANDFILL

SG NO.	X	Y	EAST	NORTH	FID (PPM)	DEPTH (IN)	REMARKS
699	2350	3550	547468.5	1542642.5	0	22	
700	2400	3550	547518.5	1542642.5	0	22	
701	2400	3500	547518.5	1542592.5	0	22	
702	2400	3450	547518.5	1542542.5	0	22	
703	2400	3400	547518.5	1542492.5	0	22	
704	2400	3350	547518.5	1542442.5	0	22	
705	2400	3300	547518.5	1542392.5	0	22	
706	2400	3250	547518.5	1542342.5	0	22	
707	2450	3550	547568.5	1542642.5	0	22	
708	2450	3500	547568.5	1542592.5	0	22	
709	2450	3450	547568.5	1542542.5	0	22	
710	2450	3400	547568.5	1542492.5	0	22	
711	2450	3350	547568.5	1542442.5	0	22	
712	2450	3300	547568.5	1542392.5	0	22	
713	2450	3250	547568.5	1542342.5	0	22	
714	2450	3200	547568.5	1542292.5	0	22	
715	2450	3150	547568.5	1542242.5	0	22	
716	2450	3100	547568.5	1542192.5	0	22	
717	2450	3050	547568.5	1542142.5	0	22	
718	2450	3000	547568.5	1542092.5	0	22	
719	2450	2950	547568.5	1542042.5	0	22	
720	2450	2900	547568.5	1541992.5	0	22	
721	2450	2850	547568.5	1541942.5	0	22	
722	2450	2800	547568.5	1541892.5	0	22	
723	2450	2750	547568.5	1541842.5	0	22	
724	2500	2750	547618.5	1541842.5	0	22	
725	2550	2750	547668.5	1541842.5	0	22	
726	2600	2750	547718.5	1541842.5	0	22	
727	2650	2750	547768.5	1541842.5	0	22	
728	2700	2750	547818.5	1541842.5	0	22	
729	2700	2800	547818.5	1541892.5	0	22	
730	2650	2800	547768.5	1541892.5	0	22	underwater, may not be viable
731	2600	2800	547718.5	1541892.5	0	22	not installed, hit water line
732	2550	2800	547668.5	1541892.5	0	22	
733	2500	2800	547618.5	1541892.5	0	22	
734	2500	3550	547618.5	1542642.5	0	22	
735	2500	3500	547618.5	1542592.5	0	22	
736	2500	3450	547618.5	1542542.5	0	22	
737	2500	3400	547618.5	1542492.5	0	22	
738	2500	3350	547618.5	1542442.5	0	22	
739	2500	3300	547618.5	1542392.5	0	22	
740	2500	3250	547618.5	1542342.5	0	22	
741	2500	3200	547618.5	1542292.5	0	22	
742	2500	3150	547618.5	1542242.5	0	22	
743	2500	3100	547618.5	1542192.5	0	22	
744	2500	3050	547618.5	1542142.5	0	22	
745	2500	3000	547618.5	1542092.5	0	22	
746	2500	2950	547618.5	1542042.5	0	22	
747	2500	2900	547618.5	1541992.5	0	22	
748	2500	2850	547618.5	1541942.5	0	22	
749	2800	2850	547918.5	1541942.5	0	22	
750	2800	2900	547918.5	1541992.5	0	22	
751	2800	2950	547918.5	1542042.5	0	22	
752	2800	3000	547918.5	1542092.5	0	22	
753	2800	3050	547918.5	1542142.5	0	22	

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APPENDIX D-1
PASSIVE SOIL GAS/HAND AUGER SURVEY
OU 1, NORTH GRINDER LANDFILL

SG NO.	X	Y	EAST	NORTH	FID (PPM)	DEPTH (IN)	REMARKS
754	2800	3100	547918.5	1542192.5	0	22	
755	2800	3150	547918.5	1542242.5	0	22	
756	2800	3200	547918.5	1542292.5	0	22	
757	2800	3250	547918.5	1542342.5	0	22	
758	2800	3300	547918.5	1542392.5	0	22	
759	2800	3350	547918.5	1542442.5	0	22	
760	2800	3400	547918.5	1542492.5	0	22	
761	2800	3450	547918.5	1542542.5	0	22	
762	2800	3500	547918.5	1542592.5	0	22	
763	2800	3550	547918.5	1542642.5	0	22	
764	3000	3500	548118.5	1542592.5	0	22	
765	3000	3450	548118.5	1542542.5	0	22	
766	3050	3500	548168.5	1542592.5	0	22	
767	3050	3450	548168.5	1542542.5	0	22	
768	3100	3500	548218.5	1542592.5	0	22	
769	3100	3450	548218.5	1542542.5	0	22	
770	3150	3500	548268.5	1542592.5	0	22	
771	3150	3450	548268.5	1542542.5	0	22	
772	3100	3400	548218.5	1542492.5	0	22	
773	3150	3400	548268.5	1542492.5	0	22	
774	2900	3350	548018.5	1542442.5	0	22	
775	2950	3350	548068.5	1542442.5	0	22	
776	3000	3350	548118.5	1542442.5	0	22	
777	3050	3350	548168.5	1542442.5	0	22	
778	3100	3350	548218.5	1542442.5	0	22	
779	3150	3350	548268.5	1542442.5	0	22	
780	2900	3300	548018.5	1542392.5	0	22	
781	2950	3300	548068.5	1542392.5	0	22	
782	3000	3300	548118.5	1542392.5	0	22	
783	3050	3300	548168.5	1542392.5	0	22	
784	3100	3300	548218.5	1542392.5	0	22	
785	3150	3300	548268.5	1542392.5	0	22	
786	2900	3250	548018.5	1542342.5	0	22	
787	2950	3250	548068.5	1542342.5	0	22	
788	3000	3250	548118.5	1542342.5	0	22	
789	3050	3250	548168.5	1542342.5	0	22	
790	3100	3250	548218.5	1542342.5	0	22	
791	3150	3250	548268.5	1542342.5	0	22	
HA 1	2600	3050	547718.5	1542142.5	5000	24	2" asph over 6" cr ls, 8-18" dk br f-m SA, 18-24" br-gr br med SA, 5000 ppm over hole (0 breathing zone), 15 ppm FID over cuttings.
HA 2	2500	2850	547618.5	1541942.5	180	78	1.5" asph, 6" cr ls, 7.5"-60" wh med SA, moist at 48", 60"-78" dk br org rich peaty and rootlets med SA, terminated at 78" (no methane filter on site)
HA 3	2600	3120	547718.5	1542212.5	60	20	cloth debris
HA 4	2600	2980	547718.5	1542072.5	20	10	2" asph, 10" cr ls, br m SA, 1000 ppm FID hit, with methane filter, FID=20.
HA 5	2600	3450	547718.5	1542542.5	0	90	4" asphalt, 0-18" lt gy crushed limestone (f-med), 18"-84" lt br to tan uniform sand, f-med, root at 60", 84"-90" dk br f-m SA
HA 6	2700	3250	547818.5	1542342.5	0	120	2" asph over 18" lt gy to white f-c crushed ls, 18-48" lt br f-m SA, 48-72" lt br/tan f-m SA, 72-120" dk br f-m SA.
HA 7	2500	3250	547618.5	1542342.5	0	60	2" asph, 8" cr ls, 12-36" dk br f-m SA, 36-54" lt br to tan f-m SA, 54-60" wh med SA, 60" small metal debris, iron stained white sand, auger refusal.

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APPENDIX D-1
PASSIVE SOIL GAS/HAND AUGER SURVEY
OU 1, NORTH GRINDER LANDFILL

SG NO.	X	Y	EAST	NORTH	FID (PPM)	DEPTH (IN)	REMARKS
HA 8	2650	2850	547768.5	1541942.5	0	72	1" asph, 8"cr ls, 9-72" vy dry wh SA, no FID hits.
HA 9	2600	3520	547718.5	1542612.5	0	114	1.5" asph, 8" cr ls, 8-72" lt br to tan f-m SA, 72-102" dk br f-m SA, 114" vy dk br SA, no FID deflections.
HA 10	2530	3450	547648.5	1542542.5	0	96	1.5" asph, 8" cr ls, 8-18" dk by f-m SA, 18-78" lt br to tan SA, 78-90" br to lt br f-m SA, 90-96" vy dk br f-m SA, no FID readings.
HA 11	2600	3380	547718.5	1542472.5	0	108	2" asph, 12" cr ls, 12-72" lt br to tan f-m SA, 72-90" br to lt br f-m SA, 90-108" dk br f-m SA.
HA 12	2500	3320	547618.5	1542412.5	0	114	2" asph, 12" cr ls, 12-15" lt br f-m SA, 15-72" wh f SA, 72-114" br f-m SA, no FID hits.
HA 13	2570	3250	547688.5	1542342.5	0	114	2" asph, 8" cr ls, 8-15" lt br to br SA, 15-17" gy f SA, 17-66" wh f SA, 66-84" br to tan f-m SA, 84-114" dk br f-m SA, no FID hits.
HA 14	2600	3120	547718.5	1542212.5	0	20	2" asph, 10" cr ls, FID 15ppm, 10-16" br to dk br SA (no FID), 16-20" gy f-m SA, cloth debris, FID 100ppm (60ppm methane filter).
HA 15	2500	2920	547618.5	1542012.5	0	108	2" asph, 10" cr ls, 10-12" br f-m SA, 12-30" gy wh f SA, 30-108" wh f SA, no FID hits.
HA 16	2570	2850	547688.5	1541942.5	0	108	2" asph, 10" cr ls, 12-15" br f-m SA, 15-108" wh f SA.'
HA 17?	2300	3320	547418.5	1542412.5	0	114	0-12" dk gy m SA, 12-60" lt gy m SA, 60-78" dk gy (marble-sized rusty sand balls [concretions?], 78-102" dk gy SA, 102-114" wh SA.
HA 17?	2300	3250	547418.5	1542342.5	0	30	0-24" lt br gy m SA, 24-30" trash (razor blade dispenser, painted wood, foam rubber, amber glass.
HA 18?	2300	3180	547418.5	1542272.5	0	60	0-12" gy lt br SA, 12-24" lt gy m SA, 24-25" wh SA, 26-48" lt gy SA, 48-60" wh SA with porcelain, amber glass, rusty nodules, plastic.
HA 19?	2400	3120	547518.5	1542212.5	0	36	0-24" lt gy m SA, 24-36" br-dk gy SA (12-36" amber glass, alum foil, trash).
HA 20?	2330	3050	547448.5	1542142.5	0	48	0-12" br SA, 12-46" lt gy SA, 46-48" rusty SA, trash from 12"-48".
HA 21?	2400	2980	547518.5	1542072.5	0	114	0-12" lt br SA, 12-24" wh-gy SA, 24-114" wh m SA (no trash)
HA 22?	2300	2920	547418.5	1542012.5	0	30	0-30" lt br m SA, 12-30" trash (bottle nipple, glass, ball bearings)
HA 23?	2300	2850	547418.5	1541942.5	0	36	0-36" lt br m SA w/rusty discoloration at 12", refusal @ 36", plastic, film.
HA 24?	2300	2785	547418.5	1541877.5	0	54	0-20" gy m SA, 20-36" lt gy m SA, 36-46" dk br (org) SA, 46-54" lt gy SA, wet at 48 - no trash.

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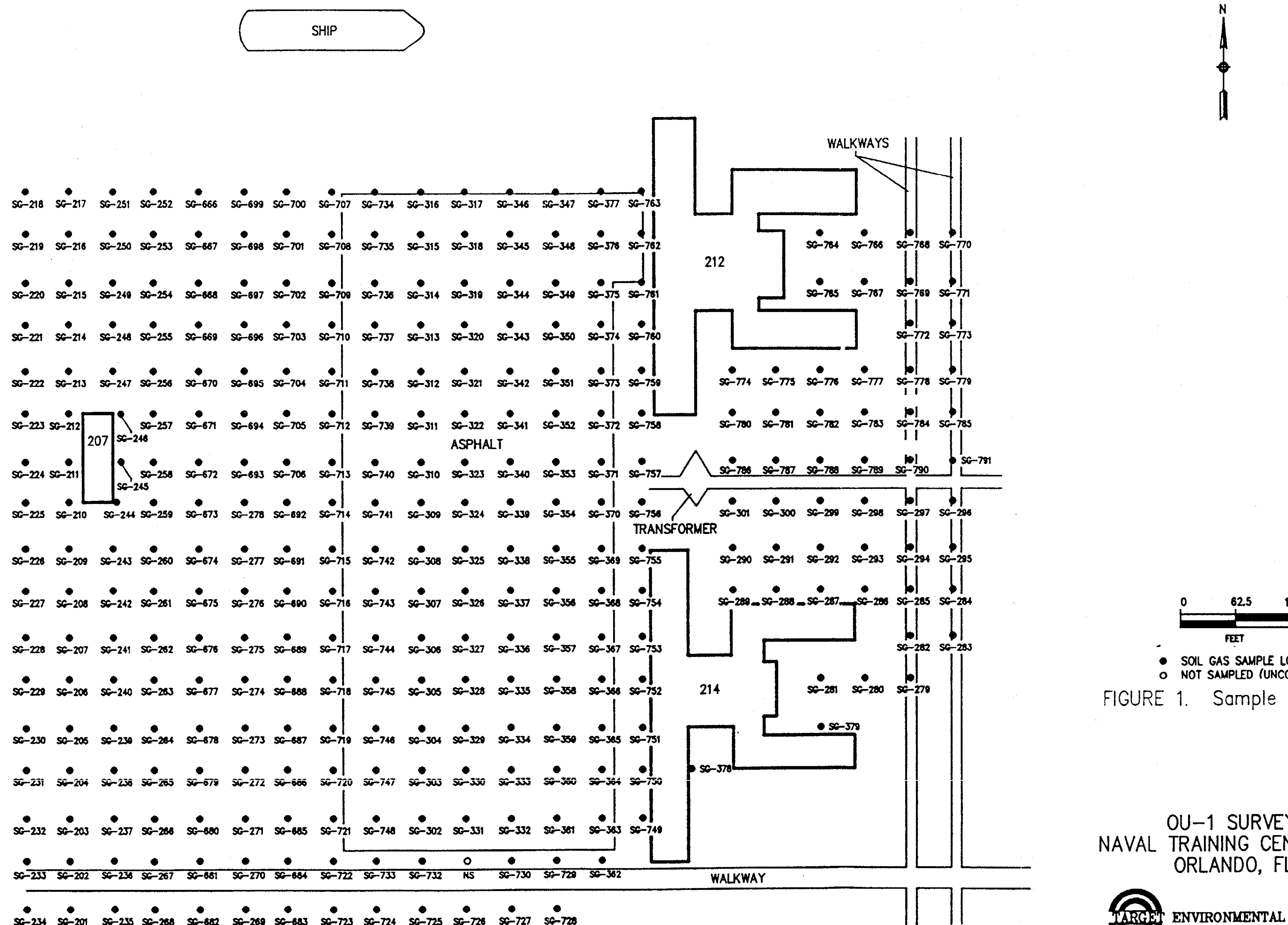

FIGURE 1. Sample Locations

OU-1 SURVEY AREA
NAVAL TRAINING CENTER ORLANDO
ORLANDO, FLORIDA

TARGET ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.

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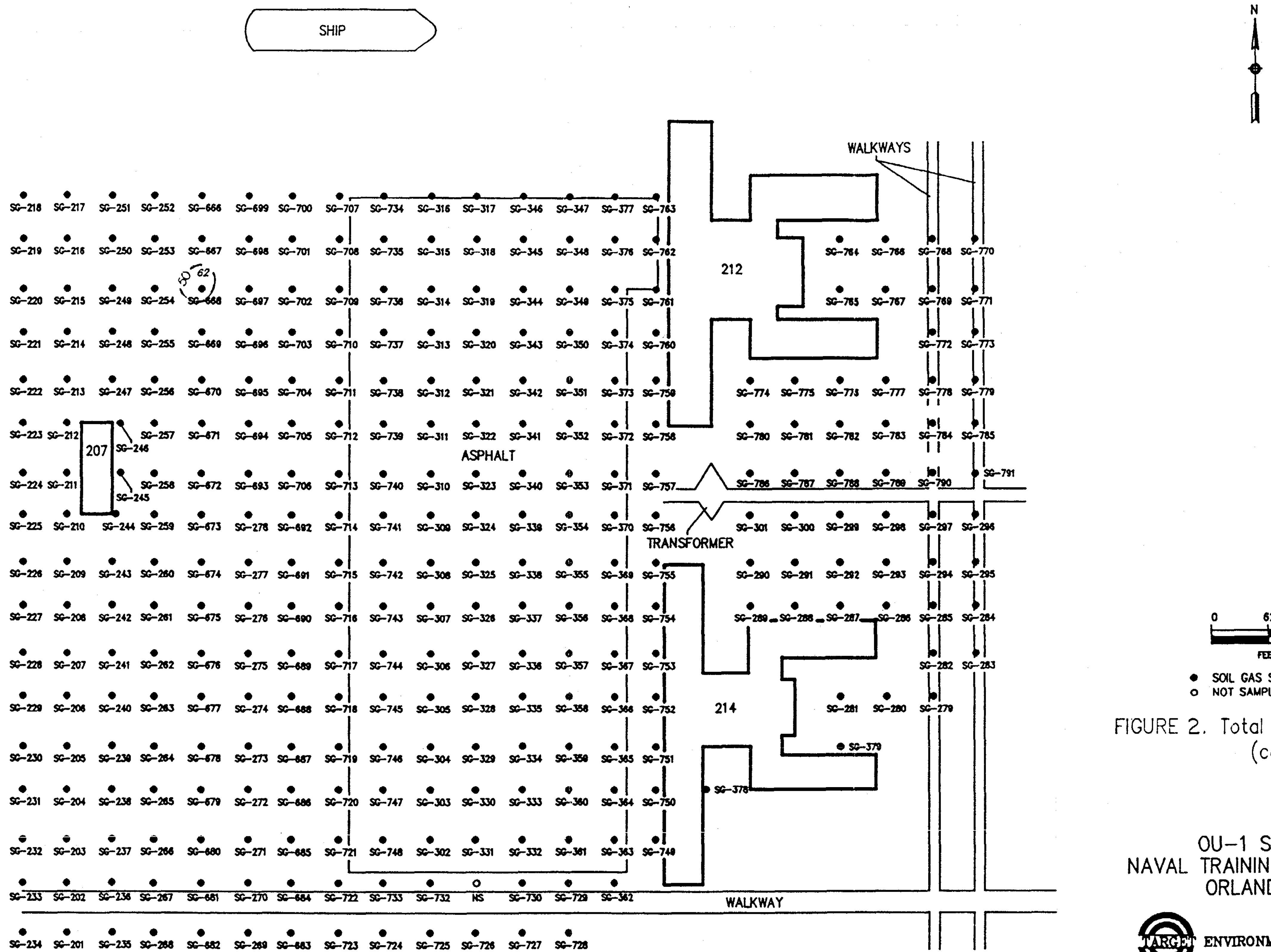


0 62.5 125
FEET

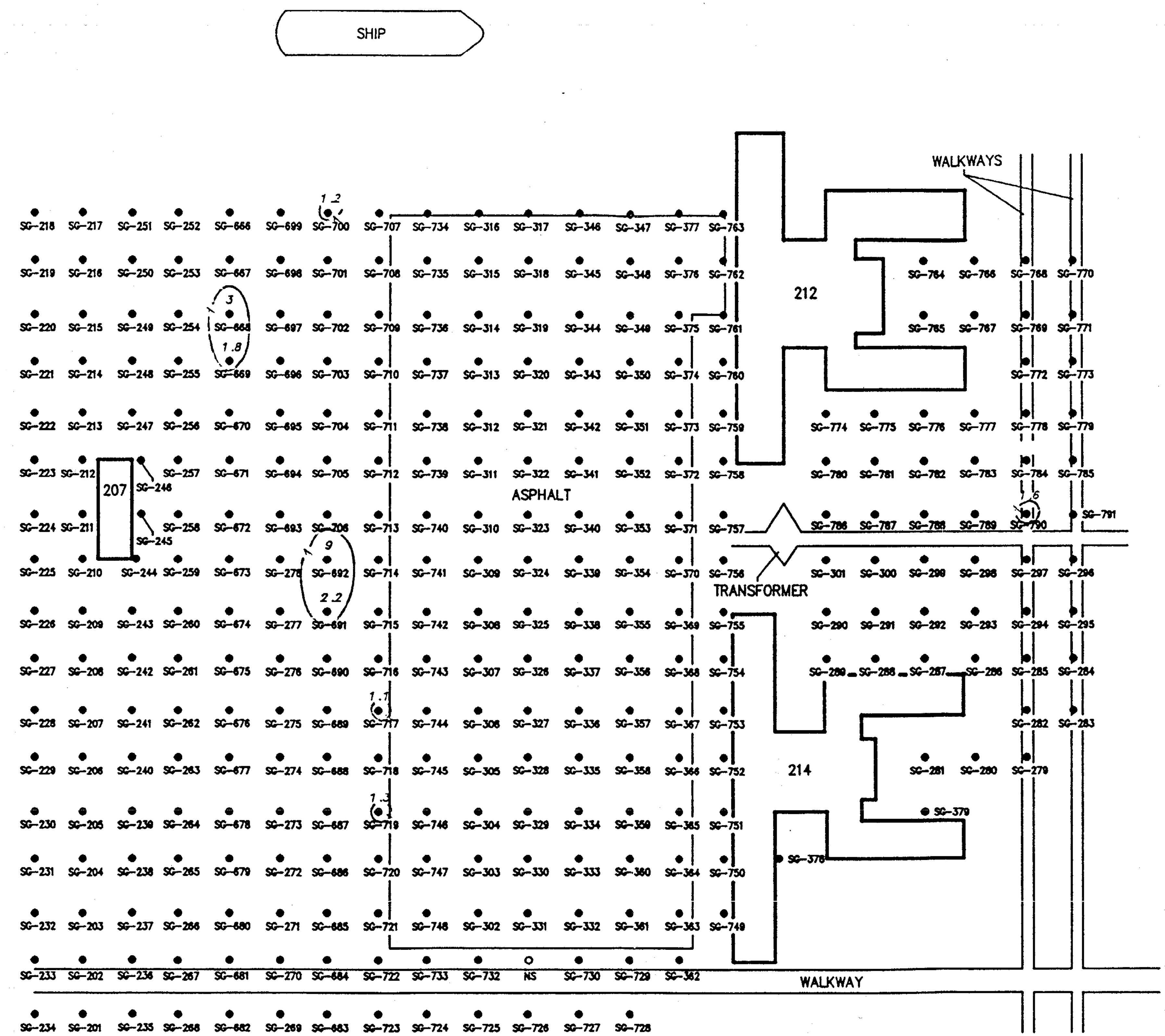
● SOIL GAS SAMPLE LOCATION
○ NOT SAMPLED (UNCOLLECTABLE)

FIGURE 2. Total FID as Naphtha (calc'd $\mu g/l$)

OU-1 SURVEY AREA
NAVAL TRAINING CENTER ORLANDO
ORLANDO, FLORIDA

TARGET ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.



0 62.5 125
FEET

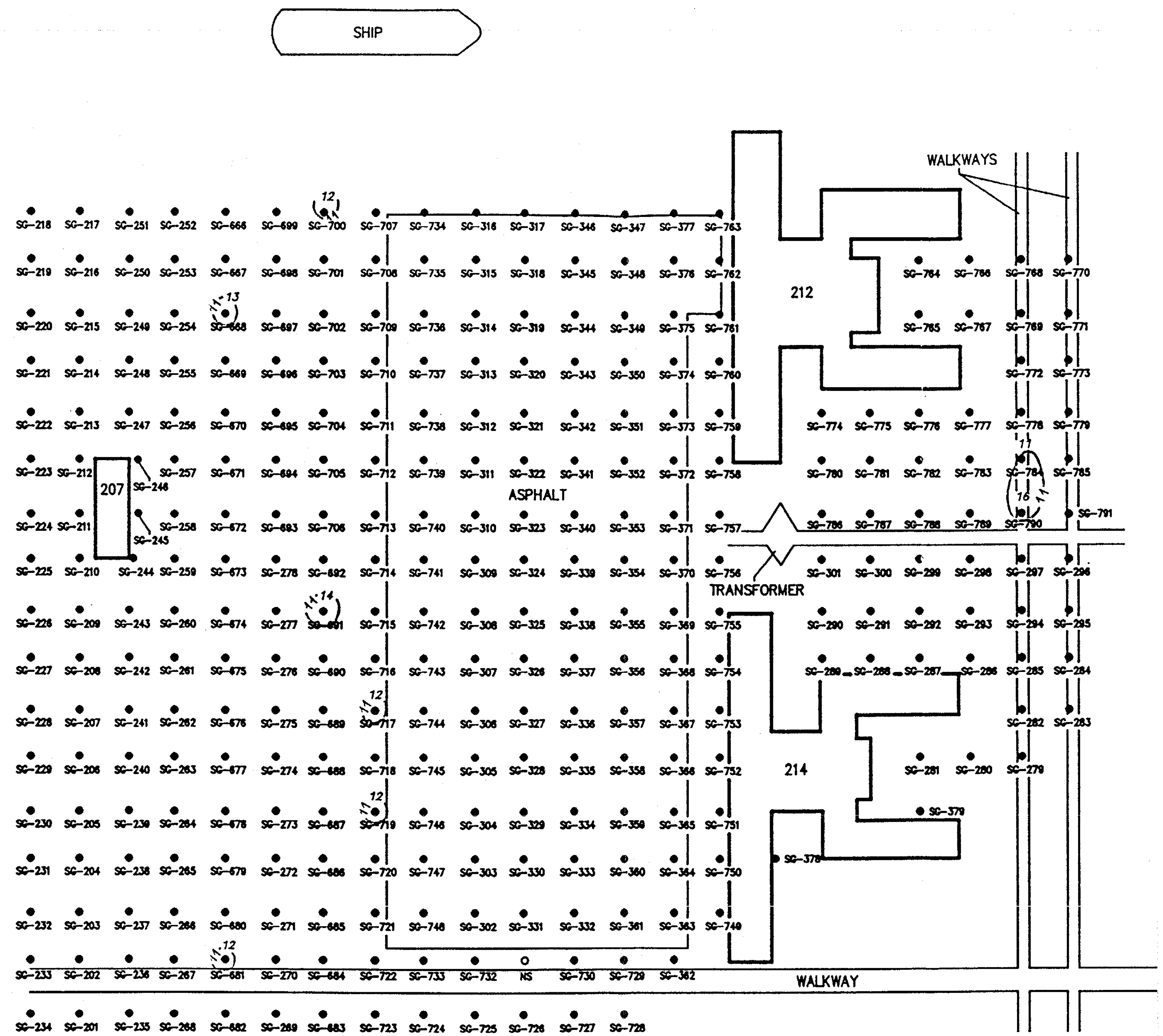
- ● SOIL GAS SAMPLE LOCATION
- ○ NOT SAMPLED (UNCOLLECTABLE)

FIGURE 3. Benzene (μg/l)

OU-1 SURVEY AREA
NAVAL TRAINING CENTER ORLANDO
ORLANDO, FLORIDA

TARGET ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.



N

0 62.5 125
FEET

● SOIL GAS SAMPLE LOCATION
○ NOT SAMPLED (UNCOLLECTABLE)

FIGURE 4. Toluene ($\mu g/l$)

OU–1 SURVEY AREA
NAVAL TRAINING CENTER ORLANDO
ORLANDO, FLORIDA

TARGET ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.

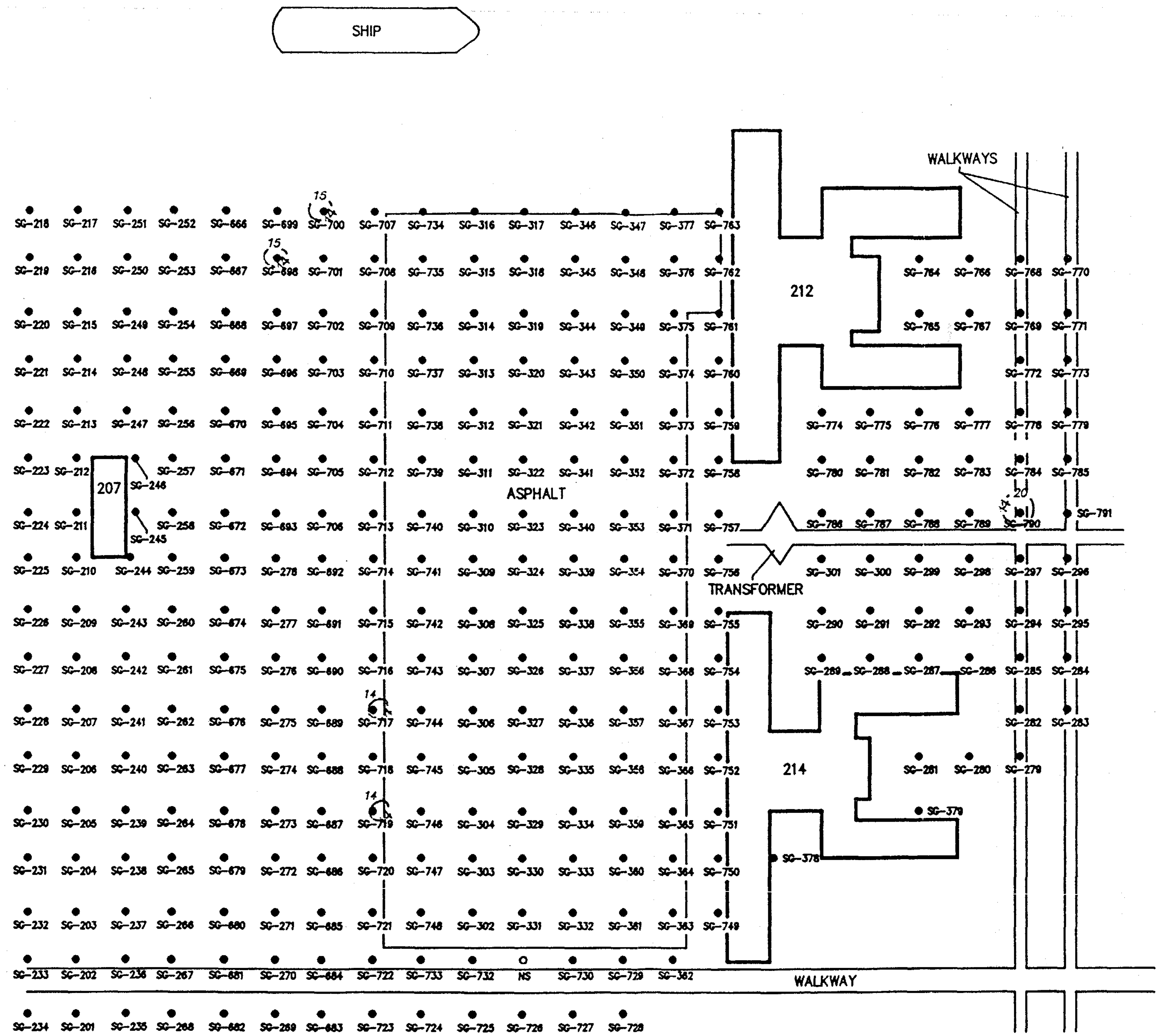


FIGURE 5. Xylenes (μg/l)

OU-1 SURVEY AREA
NAVAL TRAINING CENTER ORLANDO
ORLANDO, FLORIDA

TARGET ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.

APPENDIX D-2. FIELD GC RESULTS
PERMANENT SOIL VAPOR IMPLANTS
OU 1, NORTH GRINDER LANDFILL

	SAMPLE ID	EASTING	NORTHING	METHANE	BENZENE	TOLUENE	ETHYLBENZENE	M-,P-XYLENE	O-XYLENE	TCE	PCE	DCA	ΣBETX	Σchlor	ΣVOCs
SG01	U1A001	2100	3550	0.0	0.10	0							0.10	0	0.1
SG02	U1A002	2150	3550	0.0									0.00	0	0
SG03	U1A003	2200	3550	0.0							8.4		0.00	8.4	8.4
SG04	U1A004	2250	3550	0.0									0.00	0	0
SG05	U1A005	2300	3550	0.0									0.00	0	0
SG06	U1A006	2350	3550	0.0									0.00	0	0
SG07	U1A007	2400	3550	0.0									0.00	0	0
SG08	U1A008	2450	3550	0.0									0.00	0	0
SG09	U1A009	2500	3550	0.0									0.00	0	0
SG10	U1A010	2550	3550	0.0									0.00	0	0
SG11	U1A011	2600	3550	0.0									0.00	0	0
SG12	U1A012	2650	3550	0.0									0.00	0	0
SG13	U1A013	2700	3550	0.0									0.00	0	0
SG14	U1A014	2750	3550	0.0				2					2.00	0	2
SG15	U1A015	3000	3500	0.0									0.00	0	0
SG16	U1A016	3050	3500	0.0									0.00	0	0
SG17	U1A017	3100	3500	0.0									0.00	0	0
SG18	U1A018	3150	3500	0.0								0.3	0.00	0.3	0.3
SG19	U1A019	3150	3450	0.0		3.8							3.80	0	3.8
SG20	U1A020	3150	3400	0.0									0.00	0	0
SG21	U1A021	3150	3350	0.0									0.00	0	0
SG22	U1A022	3150	3300	0.0									0.00	0	0
SG23	U1A023	3150	3250	0.0									0.00	0	0
SG24	U1A024	3150	3200	0.0									0.00	0	0
SG25	U1A025	3150	3150	0.0									0.00	0	0
SG26	U1A026	3150	3100	0.0	1.60								1.60	0	1.6
SG27	U1A027	3150	3050	0.0									0.00	0	0
SG28	U1A028	3150	3000	0.0									0.00	0	0
SG29	U1A029	3050	2900	0.0		0.3							0.30	0	0.3
SG30	U1A030	2950	2800	0.0	2.20	0.6					0.3		2.80	0.3	3.1

Note: All concentrations (except methane) are in parts per billion (nominal).
Methane concentrations are in parts per million.

APPENDIX D-2. FIELD GC RESULTS
PERMANENT SOIL VAPOR IMPLANTS
OU 1, NORTH GRINDER LANDFILL

	SAMPLE ID	EASTING	NORTHING	METHANE	BENZENE	TOLUENE	ETHYLBENZENE	M-,P-XYLENE	O-XYLENE	TCE	PCE	DCA	ΣBETX	Σchlor	ΣVOCs
SG31	U1A031	2850	2900	0.0									0.00	0	0
SG32	U1A032	2700	2750	0.0									0.00	0	0
SG33	U1A033	2650	2750	0.0		0.1							0.10	0	0.1
SG34	U1A034	2600	2750	0.0		0.7							0.70	0	0.7
SG35	U1A035	2550	2750	0.0									0.00	0	0
SG36	U1A036	2500	2750	0.0									0.00	0	0
SG37	U1A037	2450	2750	0.0									0.00	0	0
SG38	U1A038	2400	2750	0.0									0.00	0	0
SG39	U1A039	2350	2750	0.0		0.4						0.2	0.40	0.2	0.6
SG40	U1A040	2300	2750	0.0							0.4		0.00	0.4	0.4
SG41	U1A041	2250	2750	0.0									0.00	0	0
SG42	U1A042	2200	2750	0.0									0.00	0	0
SG43	U1A043	2150	2750	0.0									0.00	0	0
SG44	U1A044	2100	2700	0.0									0.00	0	0
SG45	U1A045	2100	2750	0.0									0.00	0	0
SG46	U1A046	2100	2800	0.0		0.3					0.1	0.1	0.30	0.2	0.5
SG47	U1A047	2100	2850	0.0									0.00	0	0
SG48	U1A048	2100	2900	0.0					0.8				0.80	0	0.8
SG49	U1A049	2100	2950	0.0									0.00	0	0
SG50	U1A050	2100	3000	0.0									0.00	0	0
SG51	U1A051	2100	3050	0.0					3.3				3.30	0	3.3
SG52	U1A052	2100	3100	0.0									0.00	0	0
SG53	U1A053	2100	3150	0.0									0.00	0	0
SG54	U1A054	2100	3200	0.0									0.00	0	0
SG55	U1A055	2100	3250	0.0									0.00	0	0
SG56	U1A056	2100	3300	0.0									0.00	0	0
SG57	U1A057	2100	3350	0.0									0.00	0	0
SG58	U1A058	2100	3400	0.0									0.00	0	0
SG59	U1A059	2100	3450	0.0				6.9					6.90	0	6.9
SG60	U1A060	2100	3500	0.0									0.00	0	0

Note: All concentrations (except methane) are in parts per billion (nominal).
Methane concentrations are in parts per million.

APPENDIX E

SOIL BORING LOGS

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill		**Boring ID:** OLD-U1-03C
Client: SOUTHDIVNAVFACENGCOM			**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.		**Date started:** 06/16/95	**Compltd:** 06/16/95
Northing: 1,541,984.68	**Easting:** 547,139.61	**TOC elev.:** 119.61	**Protection level:** D
ABB Rep.: WDO	**Type of OVM.:** Porta FID	**Total depth:** 58Ft.	**Dpth to ▽̲** 6 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
					Silty SAND, gray brown		SM	
					Silty SAND, yellow brown; fine quartz sand, some orange mottling		SM	
				0				4,3
5				0	SAND, white, fine to medium quartz sand, trace black fine sand; wet at 6 feet		SP	5,5
				0			SM	7,9 ▽̲
				0				10,13
				0				2,2
				0				5,9
10				0				9,12
				0				17,12
				0				5,16
				0	Silty SAND, dark brown, fine to medium, subangular to subrounded quartz sand; saturated			13,9
				0				5,12
15				0				13,15
				0				10,16
				0				23,20
				0				21,50=3/10
				0				--,--
20				0				14,18
				0				29,46
				0				8,27
				0				44,50
				0				4,15
25				0				25,24
				0				5,8
				0			ML	17,20
				0	Clayey, sandy SILT, gray tan, fine quartz sand, hard, slightly plastic			6,8
				0				8,8
30				0				12,15

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-03C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.	**Date started:** 08/18/95	**Compltd:** 08/18/95

Northing: 1,541,984.68	**Easting:** 547,139.81	**TOC elev.:** 119.81	**Protection level:** D
ABB Rep.: WDO	**Type of OVM.:** Porta FID	**Total depth:** 58Ft.	**Dpth to ⊻** 8 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Continued from PAGE 1

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
							ML	
				0				25,18
				0				3,3
				0				3,4
				0			CH	10,9
35				0	CLAY, trace sand, light green gray, plastic			10,8
				0			SM	2,2
				0				2,3
				0			ML	3,3
				0				5,7
40				0				1,1
				0	Clayey SILT with sand, pale green, slightly plastic, coarsens to clayey silty SAND at 38 feet, clayey horizons at 41 and 45 feet			2,4
				0				7,8
				0				8,10
				0				3,3
45				0				3,3
				0				2,2
				0				10,14
				0				3,2
				0				3,4
50				0			SP	2,4
				0				8,22
				0	SAND, slightly silty, green, fine to medium quartz sand. Silty clay with thin sand laminae 51.5 to 52.5 feet.			3,8
				0				12,13
				0				15,18
55				0				23,22
				0	CLAY, silty, green-gray, plastic		CH	7,8
				0				2,3
60								

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	Site: OU 1, North Grinder Landfill	Boring ID: OLD-U1-06C
Client: SOUTHDIVNAVFACENGCOM		Job No.: 08519.70
Contractor: Groundwater Protection, Inc.	Date started: 06/20/95	Compltd: 06/20/95
Northing: 1,542,388.89	Easting: 547,134.90	TOC elev.: 117.19	Protection level: D
ABB Rep.: WDO	Type of OVM.: Porta FID	Total depth: 58Ft.	Dpth to ▽ 16 Ft.
Checked by:	Method: HSA		Casing dia.: 10 in.

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
							SP	
				0	SAND, trace silt, mostly fine, some medium quartz sand, off-white, sub-rounded, loose, dry to damp, red/brown laminar mottling at 9 ft.			4,4
5	70%			0				8,6
				0				8,6
	80%			0				7,4
				0				5,6
	70%			0				6,6
10				0				7,7
	50%			0	Silty SAND, dark brown, mostly fine to medium sand, coarsens below 14 ft., damp, sandy silt horizons at 15 and 15.75 ft., saturated at 16 ft.		SM	6,3
				0				4,6
	70%			0				6,8
				0			SP	8,7
15	80%			0				10,10
				0				5,3 ▽
	80%			0				9,12
				0				13,25
	50%			0				50=3/10
20				0	Sandy SILT, dark to medium brown, fine to medium sand, hard, decreased sand with depth, tan silt horizons with thin irregular sand laminae at 24 ft.		ML	14,32
	50%			0				40=1/10
				0				9,32
	50%			0				4=3/10
				0				12,50
25	25%			0				4=2/10
				0				11,17
	50%			0				50,30
				0				11,8
	50%			0			ML	9,7
30				0				8,5

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-06C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.	**Date started:** 08/20/95	**Compltd:** 08/20/95
Northing: 1,542,388.89	**Easting:** 547,134.90	**TOC elev.:** 117.19	**Protection level:** D
ABB Rep.: WDO	**Type of OVM.:** Porta FID	**Total depth:** 58Ft.	**Dpth to ⊻** 18 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Continued from PAGE 1

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
	80%			0	Silty SAND with trace clay, yellow tan, fine quartz sand, slightly plastic		ML	4,5
				0				5,10
	80%			0				18,18
				0				9,8
35	70%			0				14,24
				0				5,8
	80%			0				11,21
				0	SAND, some silt, tan, fine to medium sand, trace coarse clasts, uppermost 8 in. variegated, white to orange silt horizon at 39 ft.		SP	3,8
	40%			0				10,24
40				0				9,14
	50%			0				22,28
				0				4,8
	25%			0				9,15
				0				6,8
45	25%			0				8,11
				0				3,5
	50%			0				18,18
				0	Silty SAND, green gray, fine to medium quartz sand, some black sand, shelly layer at 50 ft., nummulitids, silt decreases		SM	2,4
	60%			0				8,9
50				0				8,14
	80%			0				22,12
				0				2,2
	90%			0	SAND with silt, green, mostly medium sand, loose		SP	3,3
				0				2,4
55	50%			0				8,8
				0	CLAY with sand, green gray, plastic		CH	2,2
	40%			0				2,2
60								

Project: NTC Orlando	**Site:** Ou 1, North Grinder Landfill	**Boring ID:** OLD-U1-09C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.	**Date started:** 08/22/95	**Compltd:** 08/22/95
Northing: 1,542,787.94	**Easting:** 547,310.43	**TOC elev.:** 118.12
Protection level: D	**ABB Rep.:**	**Type of OVM.:**
Total depth: 58Ft.	**Dpth to ⊻** 17 Ft.	**Checked by:**
Method: HSA		**Casing dia.:** 10 in.

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
0					Tan, silty SAND, fine to medium, contains red mottling, dry to damp		SM	
4								1,1
5	85%							2,2
6					Brown to dark brown, silty SAND, fine to medium, increased silt content with depth, damp, 13.5 to 14 ft. tan mottling		SM	1,2
7	85%							2,3
8								2,2
9	80%							1,3
10								1,2
11	85%							1,3
12								1,1
13	60%							3,3
14								3,3
15	80%							3,4
16								1,3
17	705							4,5 ⊻
18								5,7
19	100%							6,8
20								2,2
21	805				Tan, silty SAND, fine		SM	3,3
22					Brown silty SAND, fine to medium, at 25 ft. red mottling, 6 in. silty lenses around red mottling, hard horizon at 27.5 ft.		SM	4,8
23	95%							9,14
24								9,14
25	100%							18,13
26								2,4
27	100%							9,15
28								1,3
29	80%						SM	4,4
30								2,3

Project: NTC Orlando		**Site:** Ou 1, North Grinder Landfill	**Boring ID:** OLD-U1-09C
Client: SOUTHDIVNAVFACENGCOM			**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.		**Date started:** 08/22/95	**Compltd:** 08/22/95
Northing: 1,542,787.94	**Easting:** 547,310.43	**TOC elev.:** 116.12	**Protection level:** D
ABB Rep.:	**Type of OVM.:**	**Total depth:** 58Ft.	**Dpth to ⊻** 17 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Continued from PAGE 1

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Soil class.	Blows/6-in.
31	100%				Tan, silty SAND, mostly fine with a little medium and coarse, intermittent brown mottling from 31 to 38 ft., silty horizons from 37 to 37.5 ft.	SM	4,3
32							5,6
33	100%						7,9
34							1,2
35	75%						2,3
36							2,4
37	75%						6,8
38							2,3
39	100%						4,7
40					Brown to light brown, SAND and SILT, fine, increasing sand after 47.5 ft.	SP	3,7
41	10%						7,10
42							3,3
43	10%						6,10
44							2,3
45	20%						8,9
46							2,4
47	25%						6,8
48							2,4
49	20%						8,11
50							4,10
51	20%						18,22
52					Light brown to tan silty SAND, fine	SM	4,4
53	65%				Green-gray, silty SAND, medium, some fine, 54 to 55 ft., green-gray sandy clay to clay	SM	9,19
54							9,15
55	40%						28,21
56							WO2
57	75%				Green-gray CLAY with some sand	CH	8,7
60							

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-UI-12C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.	**Date started:**	**Compltd:**
Northing: 1,543,171.05	**Easting:** 547,833.21	**TOC elev.:** 113.76
Protection level: D		
ABB Rep.: JMN	**Type of OVM.:** Porta FID	**Total depth:** 66Ft.
Dpth to ▽ 18 Ft.		
Checked by:	**Method:** HSA	**Casing dia.:** 10 in.

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
					Top 2 in. gray-brown, fine to med. silty SAND/9 in. crushed lime rock/ 1 in. gray, fine to med. silty sand		SM	
					White fine SAND, loose		SP	
				0	At 5 ft., 0.1 ft. organic debris and red, hard silty sand			2,3
5	50%			0				3,3
				0	Tan, fine-medium silty SAND		SM	4,4
	95%			0				4,4
				0			SM	4,4
	85%			0				4,5
10				0				4,5
	90%			0				5,5
				0	Brown, fine to medium, silty SAND, damp at 12 ft.			2,2
	75%			0				4,6
				0				7,7
15	85%			0				7,9
				0				2,3
	65%			0				4,4
				0	Saturated at 18 ft.			4,4 ▽
	100%			0	Hard from 19.5 to 20 ft.			9,9
20				0				2,4
	55%			0				5,10
				0				19,30=8/10
	50%			0				--,--
				0	Light brown, fine to medium silty SAND, a few coarse subrounded quartz grains		SM	14,21
25	50%			0			SM	19,26
				0				33,32
	60%			0	Silty SAND, brown, fine to medium sand, grades to reddish brown at 27 ft., gravel clasts of cemented sand at 29 ft.			15,27
				0				10,16
	100%			0				24,36
30				0				27,60=6/10
	60%			0				--,--
				0				5,15
	55%			0				20,30
				0				2,5
35	100%			0				12,20

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	Site: OU 1, North Grinder Landfill	Boring ID: OLD-U1-12C
Client: SOUTHDIVNAVFACENGCOM		Job No.: 08519.70
Contractor: Groundwater Protection, Inc.	Date started:	Compltd:
Northing: 1,543,171.05	Easting: 547,833.21	TOC elev.: 113.78	Protection level: D
ABB Rep.: JMN	Type of OVM.: Porta FID	Total depth: 66Ft.	Dpth to ▽ 18 Ft.
Checked by:	Method: HSA		Casing dia.: 10 in.

Continued from PAGE 1

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
				0			SM	8,11
	100%			0			SP	15,19
				0				12,16
	100%			0				19,36
40				0				6,8
	50%			0				9,13
				0				9,9
	55%			0				13,16
				0				7,10
45	0			0	SAND to silty sand, fine to medium sand, tan			14,17
				0				8,11
	80%			0				14,20
				0				7,8
	100%			0				12,17
50				0				8,11
	100%			0				15,19
				0				8,11
	100%			0				14,16
				0				6,8
55	100%			0			SP	13,14
				0				7,11
	25%			0				14,20
				0	SAND with silt, olive green, fine to medium sand			7,14
	10%			0				17,18
60				0				15,22
	0			0				33,39
				0				5,13
	10%			0				30,22
				0			CH	3,2
65	25%			0	CLAY, green-gray, plastic			2,6
70								

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando		**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-15C
Client: SOUTHDIVNAVFACENGCOM			**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.		**Date started:**	**Compltd:**
Northing: 1,542,809.78	**Easting:** 548,018.87	**TOC elev.:** 113.99	**Protection level:** D
ABB Rep.: G. Mudd	**Type of OVM.:**	**Total depth:** 58Ft.	**Dpth to ▽** 18 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Soil/Rock Description and comments	Soil class.
Gray SAND with some silt, fine to medium	SP
Tan SAND with a little silt, fine to medium	SP
Light brown, silty SAND, fine, % silt increased with depth	SM
Gray-brown, sandy SILT, fine	SM
Light brown, silty SAND, fine, % silt increases with depth, color becomes darker with depth, partially cemented in places	SP
Dark brown, silty SAND, finer than above, thin (<2 in.) lenses of sandy silt, moist	SM
Cream-tan silty SAND	SM
Light brown-brown, silty SAND, fine, partially cemented lenses encountered from 20 to 21 ft., wet	SM
Dark brown, silty SAND, fine, partially cemented, silt 25-50%	SM
Light brown, silty SAND, fine to coarse, silt <25%	SM
Dark brown, silty SAND, fine with a little coarse and medium, partially cemented in areas	SP
Light brown SAND with a little silt, fine, intermittent lenses of dark brown-black silty sand	

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Blows/6-in.
4					1,2
5	80%				2,3
6					1,3
7	85%				2,3
8					2,2
9	95%				4,4
10					2,3
11	70%				3,2
12					4,4
13	75%				7,9
14					3,5
15	60%				5,8
16					1,3
17	80%				7,4
18					2,2 ▽
19	60%				4,6
20					5,9
21	100%				11,20
22					5,6
23	100%				6,6
24					2,3
25	100%				8,9
26					2,2
27	100%				4,7
28					7,12
29	100%				17,18
30					2,2

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-15C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.	**Date started:**	**Compltd:**
Northing: 1,542,809.78	**Easting:** 548,018.87	**TOC elev.:** 113.99	**Protection level:** D
ABB Rep.: G. Mudd	**Type of OVM.:**	**Total depth:** 56Ft.	**Dpth to ∇** 18 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Continued from PAGE 1

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
							SP	
	100%				Light brown, silty (25-50%) sand, very fine sand		SM	4,7
								8,12
	100%							14,20
					Light brown SAND with a little silt, fine to coarse, sand size increases with depth, thin (<2 in.) layer of phosphate-rich (>50%) zones 38 to 40 ft.		SW	2,3
35	75%							6,10
								6,11
	100%							14,20
								1,2
	90%							2,8
40								3,8
	70%							8,15
					Tan, silty (<25%) SAND, fine, <1/16 in. diameter phosphate grains throughout with slightly higher percentage in thin (<1/2 in.) lenses		SP	4,8
	90%							12,18
								4,6
45	90%							12,16
								7,17
	90%				Light green, silty (25-50%) SAND, fine		SM	34,50=9/10
					Light green SAND, fine to coarse, sub- to well-rounded, grains white, clear, no phosphate		SW	4,8
	10%							21,24
50								6,12
	40%							23,40
					Green silty, sandy CLAY, soft, low cohesion		SC	3,3
	10%							8,9
					Dark green silty CLAY, stiff, low cohesion		CH	2,2
55	25%							4,7
60								

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-18C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.	**Date started:**	**Compltd:**
Northing: 1,543,175.26	**Easting:** 548,409.38	**TOC elev.:** 109.35
Protection level: D		
ABB Rep.: WDO	**Type of OVM.:** Porta FID	**Total depth:** 49Ft.
Dpth to ⊻ 15 Ft.		
Checked by:	**Method:** HSA	**Casing dia.:** 10 in.

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
					Silty SAND, gray, mostly fine sand, some brown mottling		SM	
				0	SAND, trace silt, dark brown to red brown, some black mottling, partially cemented, hard		SP	20,40
5				0				--,--
				0				8,19
				0				5=3/10
				0				20,18
				0				64,--
10				0	SAND, some silt, mostly fine to medium sand, trace coarse, well- rounded frosted grains, thin white and black laminae, black laminae coarser, hard, wet at 14 ft.		SP	9,8
				0				25,50
				0				10,14
				0				50=4/10
				0				16,27
15				0				27,33 ⊻
				0				2,13
				0				13,8
				0				4,5
				0	Silty SAND, black, fine sand, silt decreases with depth, tan horizon 28 to 29 ft.		SP	9,11
20				0				2,3
				0				6,8
				0				7,10
				0				19,22
				0				2,2
25				0				4,11

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-18C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.	**Date started:**	**Compltd:**

Northing: 1,543,175.28	**Easting:** 548,409.38	**TOC elev.:** 109.35	**Protection level:** D
ABB Rep.: WDO	**Type of OVM.:** Porta FID	**Total depth:** 49Ft.	**Dpth to ▽** 15 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Continued from PAGE 1

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
							SP	
				0				6,15
				0				20,29
				0				2,2
				0				6,15
30				0				1,8
				0				23,40
				0				6,22
				0				42,--
				0				12,30
35				0				38,40=2/10
				0				4,10
				0				38,50=2/10
				0				7,12
				0				17,30
40				0				5,6
				0				14,25
				0	SAND, some silt, olive green, fine to medium sand, trace coarse well- rounded quartz grains		SP	6,19
				0				31,30
				0				7,6
45				0				15,15
				0				N,5
				0	CLAY, trace silt, green-gray, plastic		CH	4,5
				0				5,7
50								

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-21C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.	**Date started:**	**Compltd:**

Northing: 1,542,706.99	**Easting:** 548,355.76	**TOC elev.:** 112.81	**Protection level:** D
ABB Rep.: WDO	**Type of OVM.:** Porta FID	**Total depth:** 52Ft.	**Dpth to ⊻** 18 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
					Silty SAND, gray brown, fine sand, some organic debris, dry to damp, loose		SM	
				0				1,1
5				0	SAND, trace organic silt, yellow, mostly fine subrounded sand		SP	1,2
				0				2,1
				0			SM	2,2
				0				1,2
				0				1,3
10				0	SAND, some silt, light brown, fine to medium sand, silt increases below 10 ft.			4,16
				0				12,8
				0				5,15
				0				25,24
				0				12,12
15				0				9,16
				0				4,10
				0			SM	14,9
				0	Silty SAND, dark brown to tan, fine subrounded sand			4,4 ⊻
				0				4,5
20				0				5,5
				0			SP	8,12
				0				5,5
				0	SAND, little silt, black, fine to medium sand, sulfur odor			8,8
				0				12,14
25				0				25,29
				0				5,6
				0				5,7
				0				9,12
				0			SP	20,21
30				0				4,12

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill		**Boring ID:** OLD-U1-21C
Client: SOUTHDIVNAVFACENGCOM			**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.		**Date started:**	**Compltd:**
Northing: 1,542,706.99	**Easting:** 548,355.76	**TOC elev.:** 112.81	**Protection level:** D
ABB Rep.: WDO	**Type of OVM.:** Porta FID	**Total depth:** 52Ft.	**Dpth to ⊻** 18 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Continued from PAGE 1

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
				0	SAND, some silt, dark brown, fine quartz sand		SP	23,40
				0				22,42
				0				30=1/10
				0				12,17
35				0				36,48
				0	SAND, black, fine sand		SP	13,17
				0				31,36
				0	Silty SAND, brown, fine to medium subrounded sand		SM	4,4
				0				13,23
40				0				5,8
				0				12,19
				0	SAND, some silt, green gray, mostly fine to medium sand, trace coarse grains, sub- to well-rounded, fines downward		SP	5,10
				0				20,29
				0				8,10
45				0				11,20
				0				8,18
				0				28,45
				0				14,28
				0				27,24
50				0	CLAY, trace sand, green gray, plastic		CH	3,5
				0				8,9
55								
60								

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando		**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-24C
Client: SOUTHDIVNAVFACENGCOM			**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.		**Date started:** 6-14-95	**Compltd:** 6-14-95
Northing: 1,541,916.76	**Easting:** 548,321.18	**TOC elev.:** 115.98	**Protection level:** D
ABB Rep.:	**Type of OVM.:** Porta FID	**Total depth:** 70Ft.	**Dpth to ▽** 17 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
							SM	
				0	Silty SAND, yellow brown, mostly fine sand, dry, loose, some film			7,3
5	80%			0				4,4
				0			SM	5,4
	90%			0				3,3
				0				3,4
	90%			0	Silty SAND, brown, fine to medium sand, dry, loose, some roots, dark red brown with black mottling at 10 ft.			4,5
10				0				3,4
	80%			0				3,4
				0				3,4
	90%			0	SAND, little silt, tan brown, fine to medium sand, subround to round		SP	6,6
				0				4,5
15	95%			0	Silty SAND, dark brown, mostly fine sand, subrounded, wet at 15 ft.		SP	6,10
				0				1,3
	70%			0				3,5
				0	[Saturated at 18 ft.]			1,1
	90%			0				4,9
20				0				1,1
	70%			0				3,4
				0	SAND with silt, 22 to 24 ft.			4,4
	90%			0				6,10
				0				5,5
25	90%			0	Silty SAND with clay, tan, slightly plastic, cohesive		SM	10,10
				0				6,12
	50%			0				13,13
				0			SP	2,3
	90%			0				2,4
30				0				3,6
	90%			0				7,10
				0				1,1
	60%			0	SAND with silt, dark brown, fine to medium quartz sand, some well rounded and frosted grains. Silty horizon at 35.9 ft.			1,3
				0				3,3
35	70%			0				4,5
				0				2,6
	20%			0				11,14
				0				10,20
	100%			0			SP	25,24
40				0				1,3

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-24C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.	**Date started:** 8-14-95	**Compltd:** 8-14-95
Northing: 1,541,918,78	**Easting:** 548,321.18	**TOC elev.:** 115.98
Protection level: D		
ABB Rep.:	**Type of OVM.:** Porta FID	**Total depth:** 70Ft.
Dpth to ⊻ 17 Ft.		
Checked by:	**Method:** HSA	**Casing dia.:** 10 in.

Continued from PAGE 1

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
	70%			0			SP	3,1
				0				10,18
	50%			0				19,19
				0				2,3
45	90%			0	SAND, some silt, fine to medium sand, some coarse, sub- to well- rounded grains, some frosted, medium brown			4,8
				0				8,10
	80%			0				15,17
				0				3,5
	90%			0				9,13
50				0				7,9
	50%			0				9,12
				0				2,1
	80%			0				2,4
				0				2,4
55	NR			0			SM	5,9
				0				1,1
	90%			0				1,2
				0	SAND with silt, green gray, fine to medium sand, little coarse subrounded quartz grains, loose, silty SAND at 58 and 61.5 ft.			1,3
	85%			0				2,8
60				0				2,2
	90%			0				4,8
				0				4,8
	90%			0				8,11
				0				3,3
65	80%			0				3,7
				0				5,11
	80%			0				11,13
				0			CH	4,2
	90%			0	CLAY, green gray, plastic			3,8
70								
75								
80								

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando		**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-27C
Client: SOUTHDIVNAVFACENGCOM			**Job No.:** 08519.70
Contractor: GPI		**Date started:** 8-12-95	**Compltd:** 8-12-95
Northing: 1,541,801.82	**Easting:** 547,833.08	**TOC elev.:** 118.81	**Protection level:** D
ABB Rep.: WDO	**Type of OVM.:** Porta FID	**Total depth:** 64Ft.	**Dpth to ∇** 14 Ft.
Checked by:	**Method:** HSA		**Casing dia.:** 10 in.

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
					Silty SAND, gray ?		SM	
							SP	
				0	SAND, off-white, fine to medium quartz sand, subrounded, some gray mottling			2,3
5				0				6,7
				0				8,7
				0				8,6
				0				2,8
				0				6,8
10				0	SAND, silty, dark brown grading to tan gray, fine to medium sand, silt decreases with depth		SM	7,10
				0				11,12
				0				3,6
				0	Silty SAND, dark brown, fine to medium quartz sand		SM	10,10
				0				7,8 ∇
15				0				9,8
				0				3,4
				0				3,6
				0				11,34
				0				36,33
20				0	Clayey SILT with sand, medium brown, hard, dry, nonplastic, fine to medium subrounded quartz sand, silty sand 21 to 21.5 ft., grades to sand after 27 ft.		ML	4,15
				0				39,36
				0				60=4/10
				0				--,--
				0				6,16
25				0				25,30
				0				3,3
				0				15,15
				0				6,9
				0				4,4
30				0				3,3
				0				5,7
				0	SAND, light tan, fine to medium quartz sand, little coarse, sub- to well-rounded, loose, dark brown 32 to 34 ft.		SP	11,12
				0				7,6
				0				7,9
35				0				13,11

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-27C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: GPI	**Date started:** 8-12-95	**Compltd:** 8-12-95
Northing: 1,541,801.82	**Easting:** 547,833.06 / **TOC elev.:** 118.81	**Protection level:** D
ABB Rep.: WDO	**Type of OVM.:** Porta FID / **Total depth:** 64Ft.	**Dpth to ▽** 14 Ft.
Checked by:	**Method:** HSA	**Casing dia.:** 10 in.

Continued from PAGE 1

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Soil class.	Blows/6-in.
				0		SP	7,10
				0			12,12
				0			4,4
				0			5,7
40				0			9,8
				0			9,8
				0			3,4
				0		SP	8,9
				0			1,2
45				0	SAND, yellow tan, mostly medium sand, little fine sand and silt, well-rounded, some frosted		3,3
				0			2,4
				0			8,8
				0			3,1
				0			1,2
50				0		SM	2,2
				0			2,4
				0			1,1
				0	Silty SAND, olive green, fine to medium sand, silty sand 53 to 54 ft.		2,1
				0			1,2
55				0			3,9
				0			3,3
				0			4,12
				0			4,7
				0			22,14
60				0			11,16
				0			28,31
				0	CLAY, trace silt, green gray, plastic	CH	3,5
				0			8,8
65							
70							

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	**Site:** OU 1, North Grinder Landfill	**Boring ID:** OLD-U1-29C
Client: SOUTHDIVNAVFACENGCOM		**Job No.:** 08519.70
Contractor: Groundwater Protection, Inc.	**Date started:** 07/30/98	**Compltd:** 08/01/98
Northing:	**Easting:**	**TOC elev.:**
Protection level: D		
ABB Rep.: W. D. Olson	**Type of OVM.:** Porta FID	**Total depth:** 68Ft.
Dpth to ⊻ 9 Ft.		
Checked by:	**Method:** HSA	**Casing dia.:** 10 in.

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
					SAND: Off-white, loose, fine, some brown mottling. Dry from 4 to 8 feet		SP	
	50%			0				4,8,8,8
5	90%			0				10,10,16,18
	90%			2	SAND: Dark brown, fine, some silt, some roots at 7.5 ft, moist, some medium quartz grains, cohesive			18,15,24
10	90%			0				9,29,39,22
	90%			0				10,19,20,21
	90%			0				8,13,10,12
15	90%			1				8,12,14,30
	50%			0	Hard at 17 feet, slightly cemented; more cemented and dense to 19 feet, friable; back to loose sand at 20 feet			30,70,ref
20	50%			0				9,10,15,12
	70%			0				12,28,44,49
	70%			0				22,24,28,57
25	90%			0	SAND: brown, fine and medium, trace silt, some fine sand and silt lenses and calcareous coarse sand grains			25,30,44,77
	50%			0				18,30,33,33
30	90%			0				9,23,30,45
	90%			0				8,9,12,15
	80%			0	Clayey, sandy SILT: gray brown, cohesive, slightly plastic		ML	10,13,13,12
35	80%			0	CLAY: gray, trace fine sand and silt; fine white sand stringer (1 mm) at 41 feet, color grades to greenish gray at 43 feet		CL	7,9,11,13
	80%			0				9,11,12,10
40	90%			0				4,4,8,8

 ABB ENVIRONMENTAL SERVICES, INC.

Project: NTC Orlando	Site: OU 1, North Grinder Landfill	Boring ID: OLD-U1-29C
Client: SOUTHDIVNAVFACENGCOM		Job No.: 08519.70
Contractor: Groundwater Protection, Inc.	Date started: 07/30/98	Compltd: 08/01/98

Northing:	Easting:	TOC elev.:	Protection level: D
ABB Rep.: W. D. Olson	Type of OVM.: Porta FID	Total depth: 68Ft.	Dpth to ▽ 9 Ft.
Checked by:	Method: HSA		Casing dia.: 10 in.

Continued from PAGE 1

Depth Ft.	Recovery	Sample	Sample ID	Headspace (ppm)	Soil/Rock Description and comments	Lithologic symbol	Soil class.	Blows/6-in.
	80%			0			CL	6,4,4,4
	NR			NA	SAND: green gray, clayey, soft, loose		SC	3,2,2,3
45								
	60%			0				2,1,1,1
	60%			0	SAND: green gray, fine and medium, trace clay and silt, some brown clay lenses, rare shell fragments, coarsens at 56 feet		SP	WOR,1,1
50	100%			0				4,7,8,16
	50%			0				2,1,1,4
	90%			0				4,5,16,23
55								
	60%			0	SAND: dark green, medium, trace silt and fine sand, well rounded grains, finer after 59 feet, medium sand with shell material 60-61 ft			8,14,16,18
	80%			0				5,1,4,3
60	80%			0				3,3,4,8
	80%			0	SAND: dark green, fine, grades to clayey fine sand at 65 feet			4,6,4,9
	90%			0				2,2,4,4
65								
	80%			0	CLAY: green gray, trace fine sand and silt, plastic		CH	1,2,2
70								
75								
80								

 ABB ENVIRONMENTAL SERVICES, INC.

APPENDIX F

MONITORING WELL DETAILS

APPENDIX F-1

MONITORING WELL CONSTRUCTION DIAGRAMS

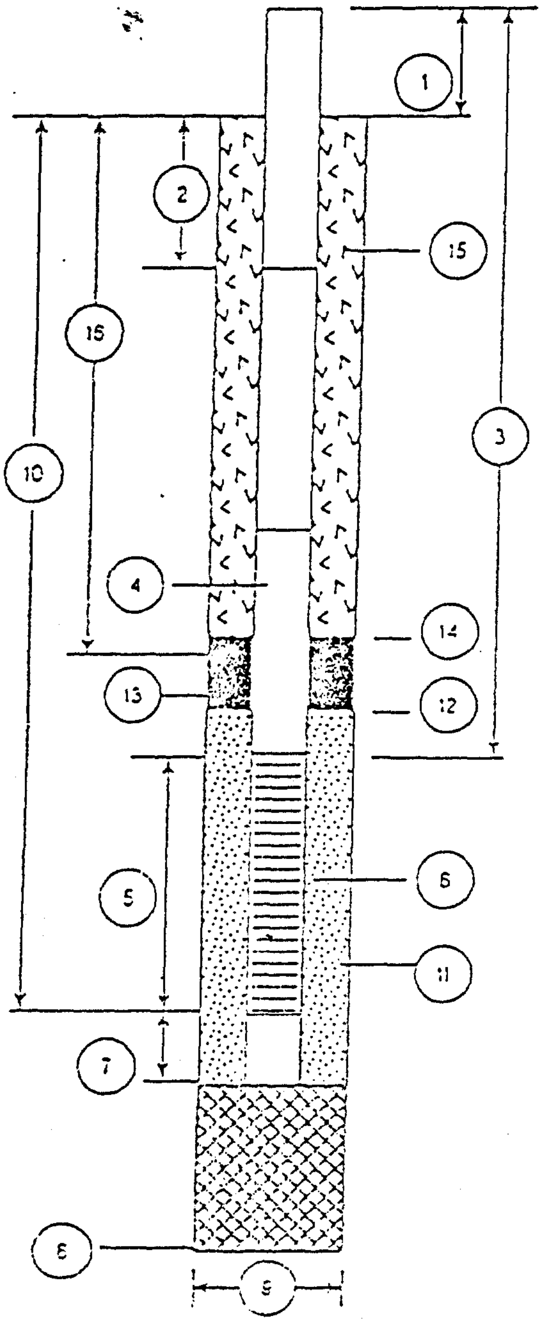
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER. OLD-UI-01A

DATE OF INSTALLATION: 6/19/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 2.5'

   Coupling Interval Depths: —
3. Total Length of Riser Pipe: 2.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 10'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 13'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 12.5'
11. Type of Screen Filter: Silica Sand

    Quantity Used: 550 lbs Size: 20/30
12. Depth to Top of Filter: 2'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips

    Quantity Used: 8 lbs
14. Depth to Top of Seal: 1.5'
15. Type of Grout:

    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal

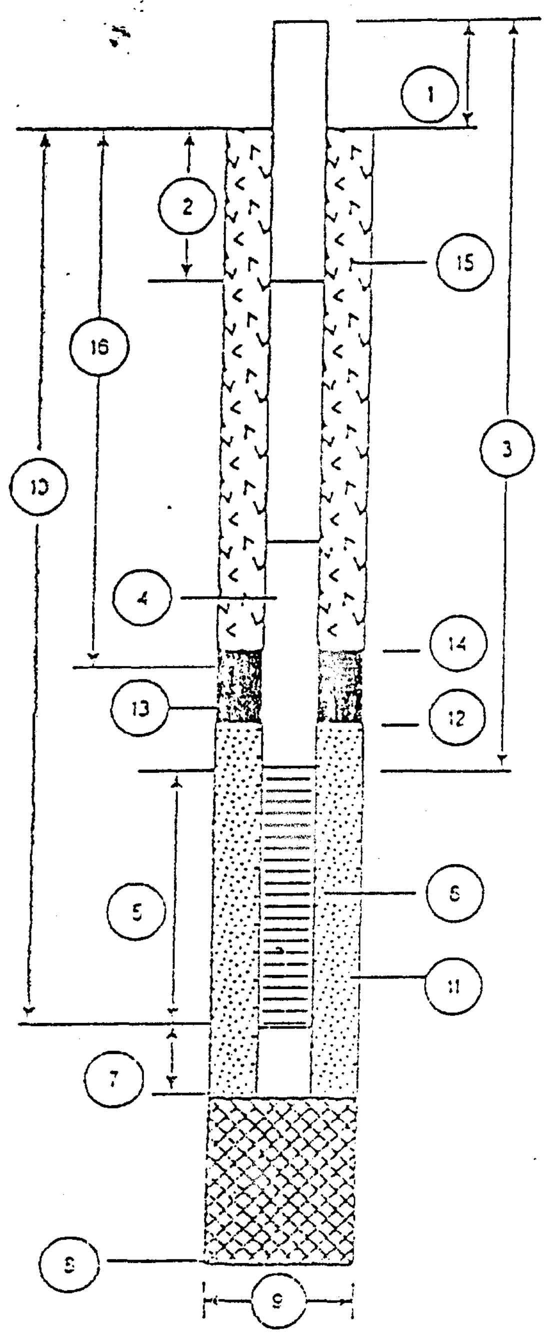
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: —

COMMENTS ON INSTALLATION

KCI-IC

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.



WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-UI-02B

DATE OF INSTALLATION: 6/19/95

1. Height of Casing above ground: FM
2. Depth to first Coupling: 2.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 22.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 28'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 27.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 20.5
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/30 lbs
14. Depth to Top of Seal: 18.5
15. Type of Grout:
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

KCI-RC

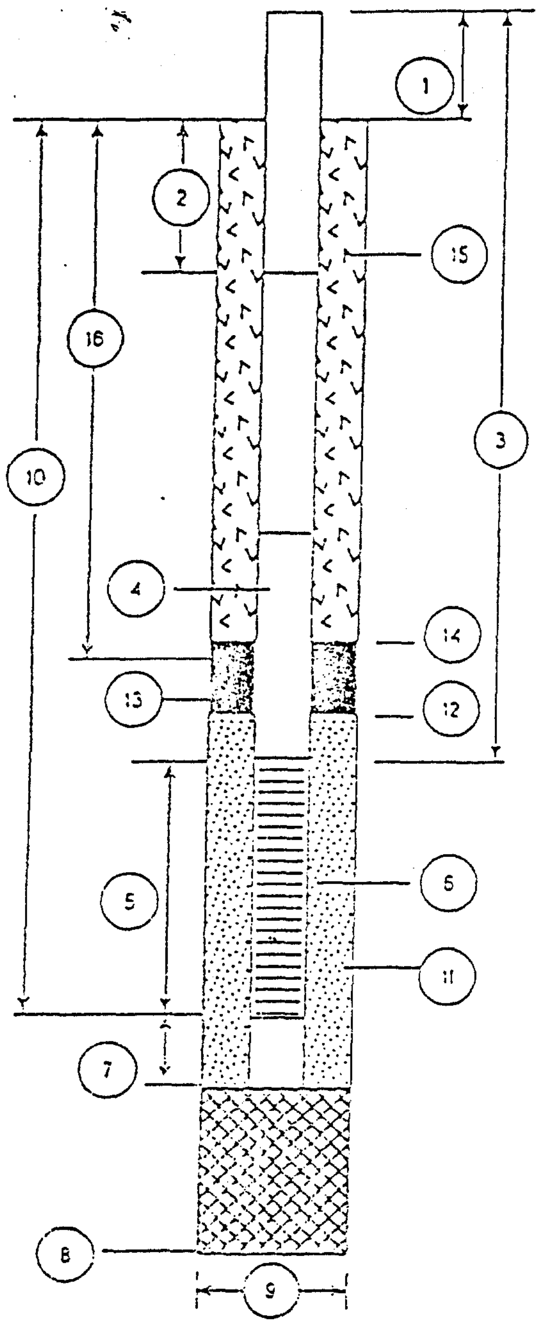
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-UI-03C

DATE OF INSTALLATION: 6/19/95



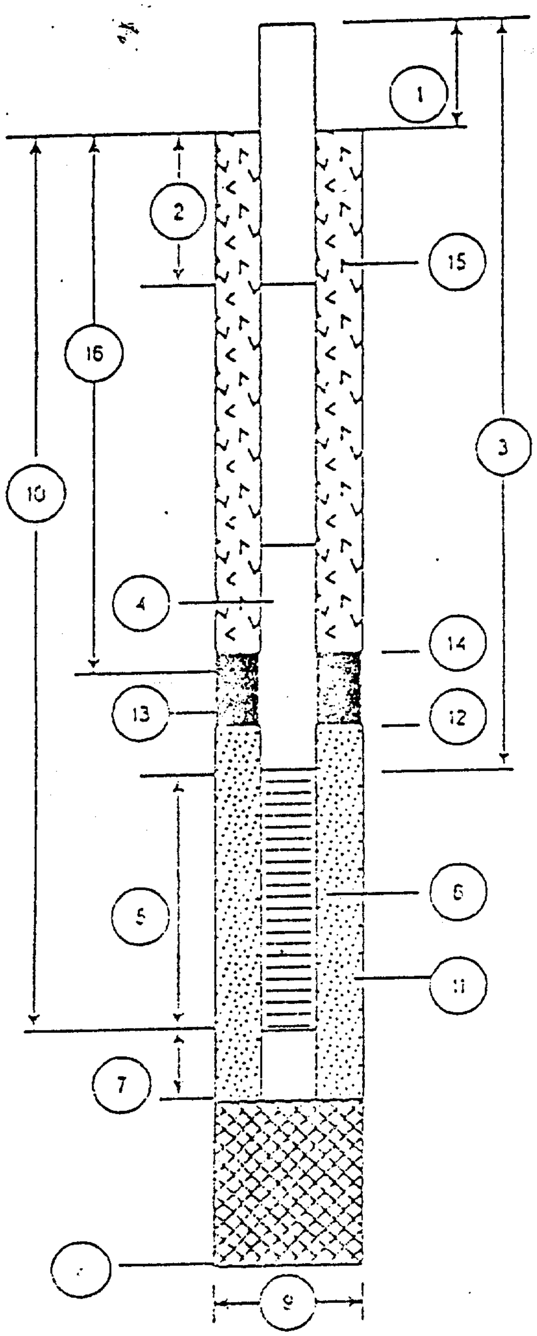
1. Height of Casing above ground: FM
2. Depth to first Coupling: 2.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 52.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 58'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 57.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 50.5'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 15 lbs
14. Depth to Top of Seal: 48.5'
15. Type of Grout: ______
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

FO-8C

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.



WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-UI-04A

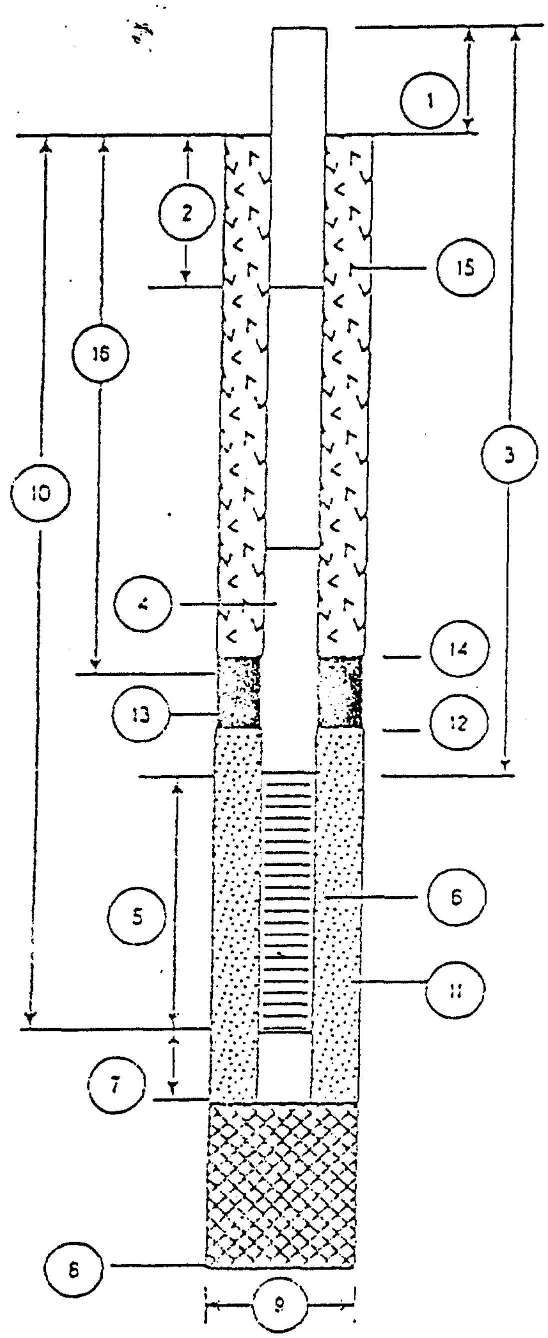
DATE OF INSTALLATION: 6/21/95

1. Height of Casing above ground: FM
2. Depth to first Coupling: 0.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 10.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 10'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 21'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 20.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 500 lbs Size: 20/30
12. Depth to Top of Filter: 8.5'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/15 lbs.
14. Depth to Top of Seal: 6.5'
15. Type of Grout:
    Grout Mixture: 300 lbs Type I Portland Cement, 12.5 lbs Bentonite gel, 12 gal of water + 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ——

COMMENTS ON INSTALLATION

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.



WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-41-05B

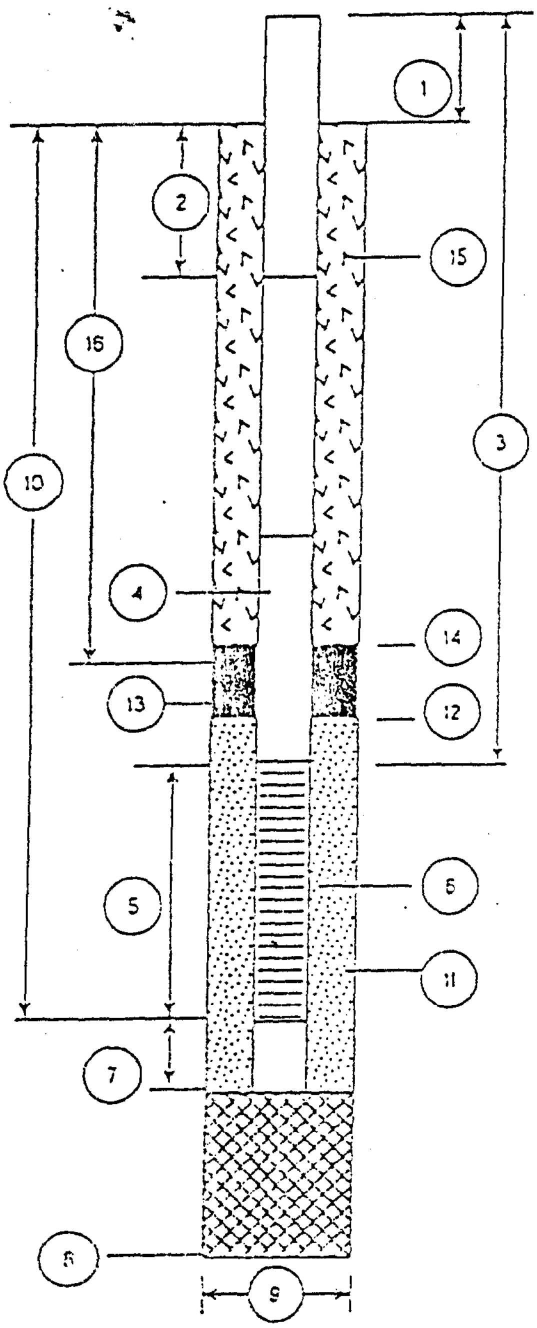
DATE OF INSTALLATION: 6/21/95

1. Height of Casing above ground: FM
2. Depth to first Coupling: 1.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 31.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 37'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 36.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 350 lbs Size: 20/30
12. Depth to Top of Filter: 29.5'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/15 lbs
14. Depth to Top of Seal: 27.5'
15. Type of Grout:
    Grout Mixture: 360 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ___

COMMENTS ON INSTALLATION

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.



WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-W1-06C

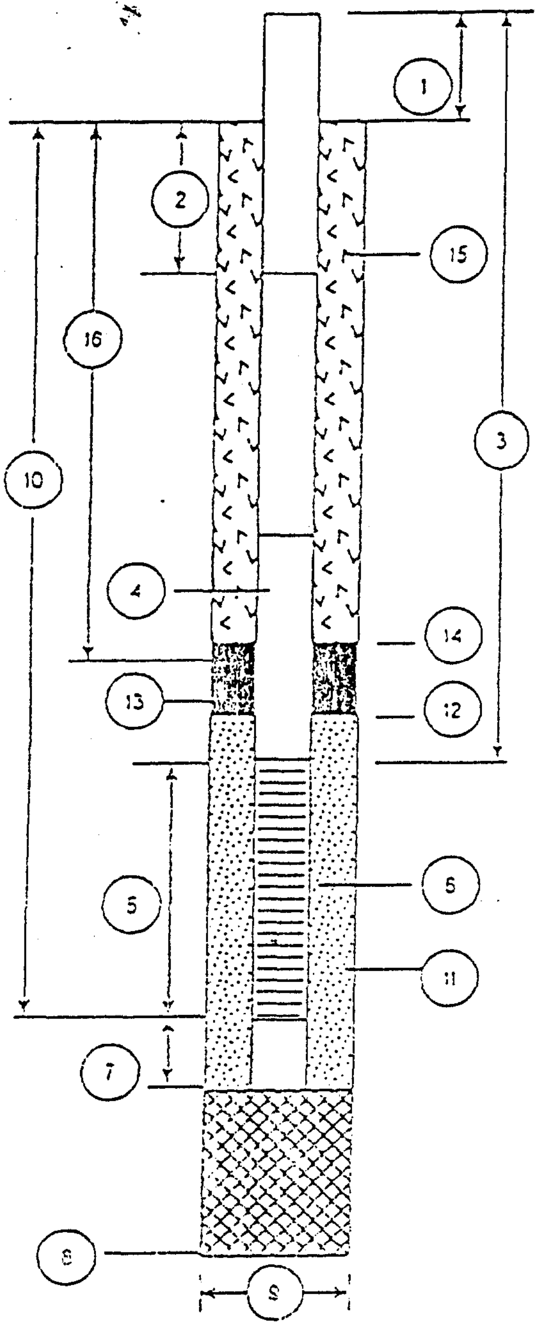
DATE OF INSTALLATION: 6/20/95

1. Height of Casing above ground: FM
2. Depth to first Coupling: 2.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 52.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 58'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 57.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 50.5'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 15 lbs
14. Depth to Top of Seal: 48.5'
15. Type of Grout:
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 5 in. Steel Casing: ___

COMMENTS ON INSTALLATION

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.



WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-WI-07A

DATE OF INSTALLATION: 6/22/95

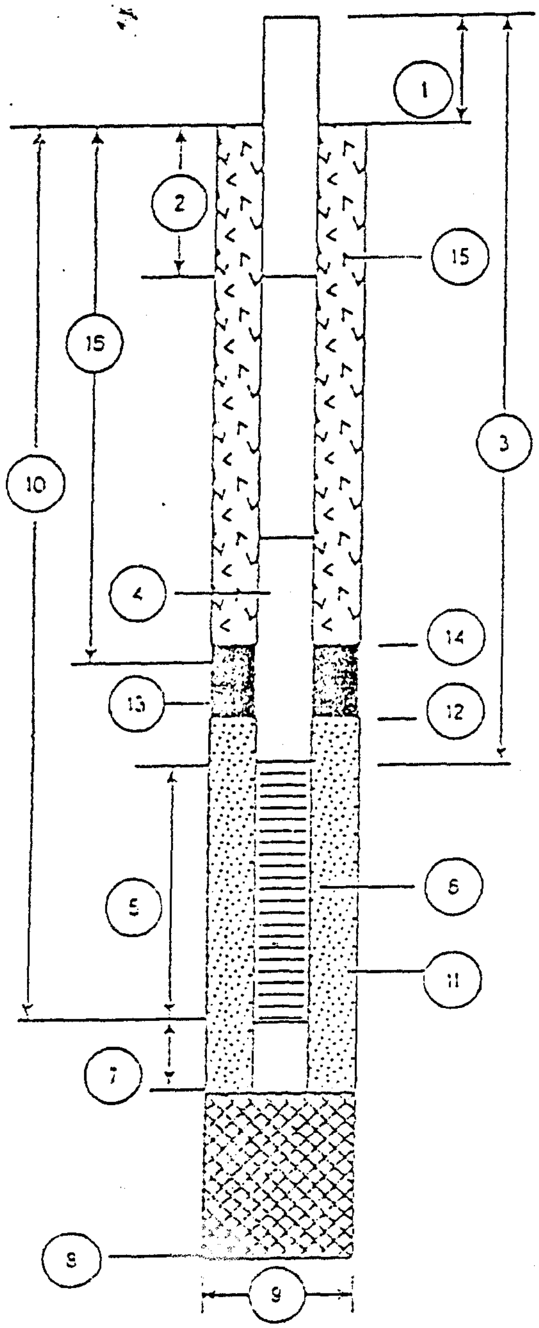
1. Height of Casing above ground: FM
2. Depth to first Coupling: 1.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 11.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 10'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 22'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 21.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 550 lbs Size: 20/30
12. Depth to Top of Filter: 10.5
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 25 lbs
14. Depth to Top of Seal: 8'
15. Type of Grout:
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 8 in. Steel Casing: ——

COMMENTS ON INSTALLATION

FO-XC

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.



WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-11-08B

DATE OF INSTALLATION: 6/22/95

1. Height of Casing above ground: FM
2. Depth to first Coupling: 5.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 35.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 41'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 40.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 400 lbs Size: 20/30
12. Depth to Top of Filter: 33.5'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 12 lbs
14. Depth to Top of Seal: 31.5'
15. Type of Grout:
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing:

COMMENTS ON INSTALLATION

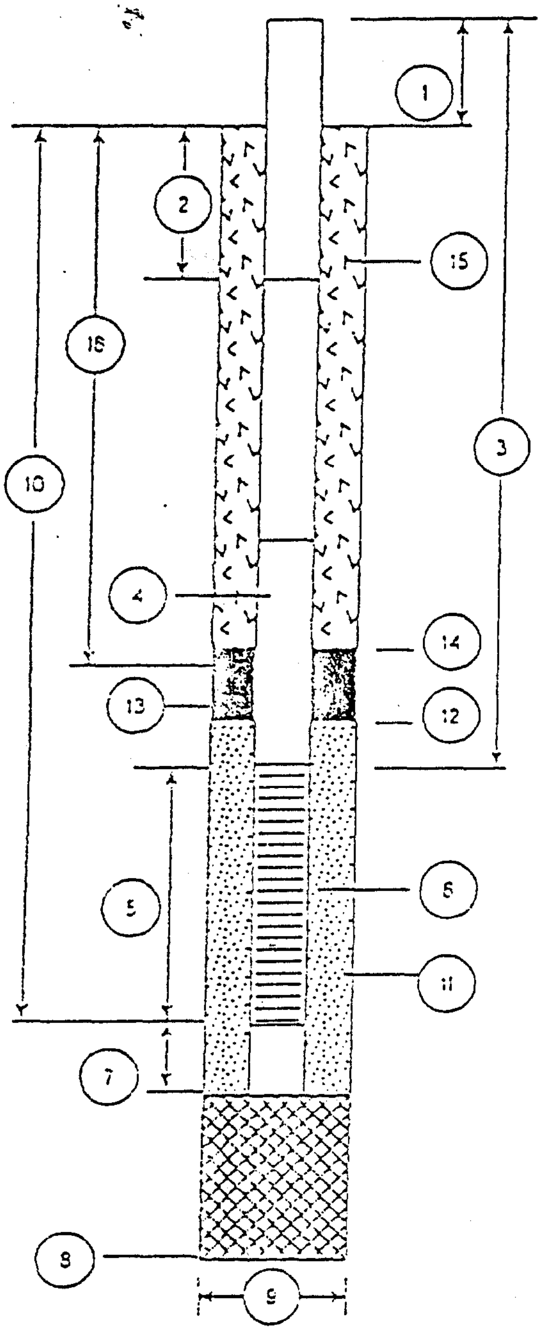
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-U1-09C

DATE OF INSTALLATION: 6/22/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 1.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 57.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 57'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 56.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 400 lbs Size: 20/30
12. Depth to Top of Filter: 49.5'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 15 lbs
14. Depth to Top of Seal: 47.5'
15. Type of Grout: ____
    Grout Mixture: 300 lbs Type I Portland Cement 12.5 lbs Bentonite gel 12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 8 in. Steel Casing: ____

COMMENTS ON INSTALLATION

YCT-1C

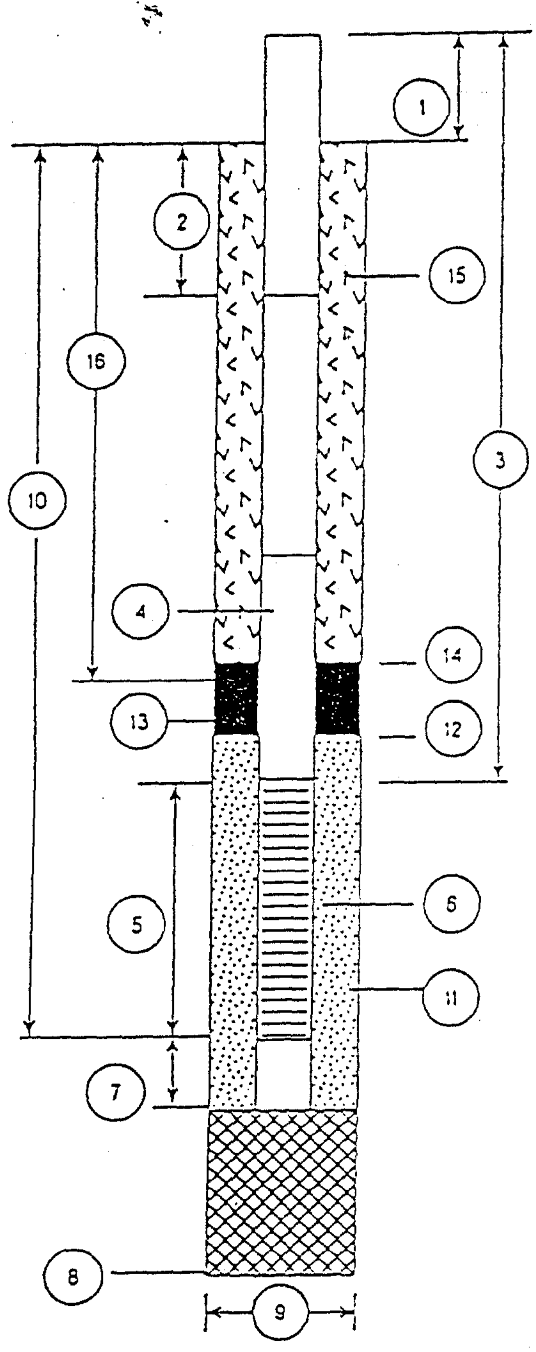
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-W-10A

DATE OF INSTALLATION: 7/7/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 2.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 12.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 10'
6. Type of Screen: 2" ID Schedule 40 0.010 slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 23'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 22.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 500 lbs Size: 20/30
12. Depth to Top of Filter: 11'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/40 lbs
14. Depth to Top of Seal: 8'
15. Type of Grout: ______
    Grout Mixture: 360 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

KCH-KC

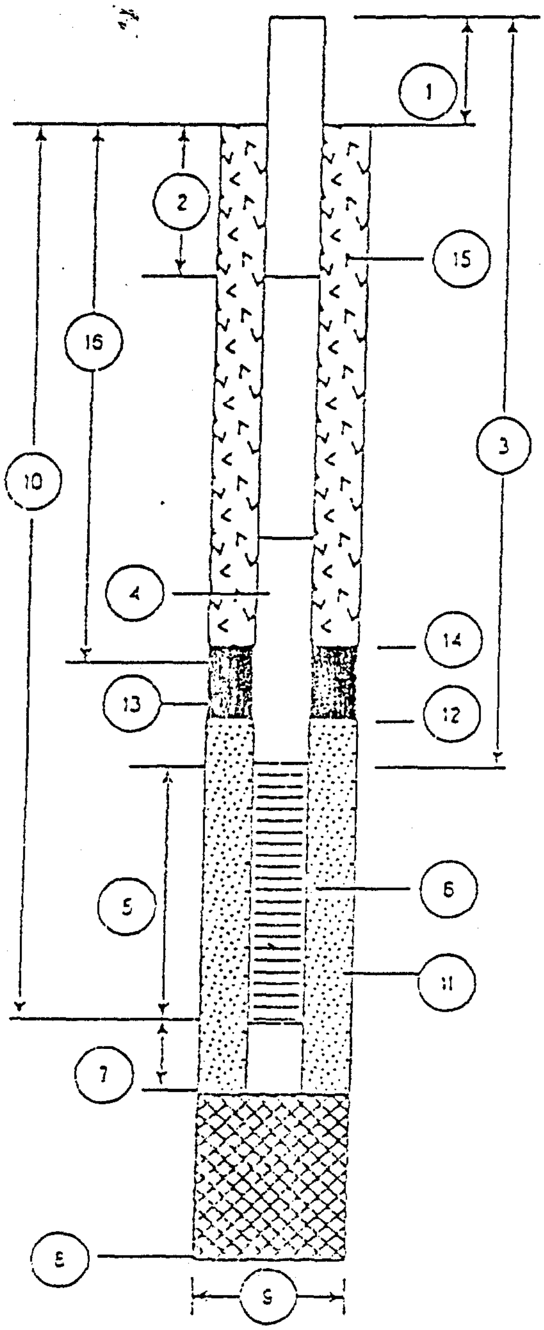
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-U1-11B

DATE OF INSTALLATION: 7/7/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 4.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 34.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 40'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 39.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 250 lbs Size: 20/30
12. Depth to Top of Filter: 33'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 15 lbs
14. Depth to Top of Seal: 31'
15. Type of Grout: ____
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

NCT-RC

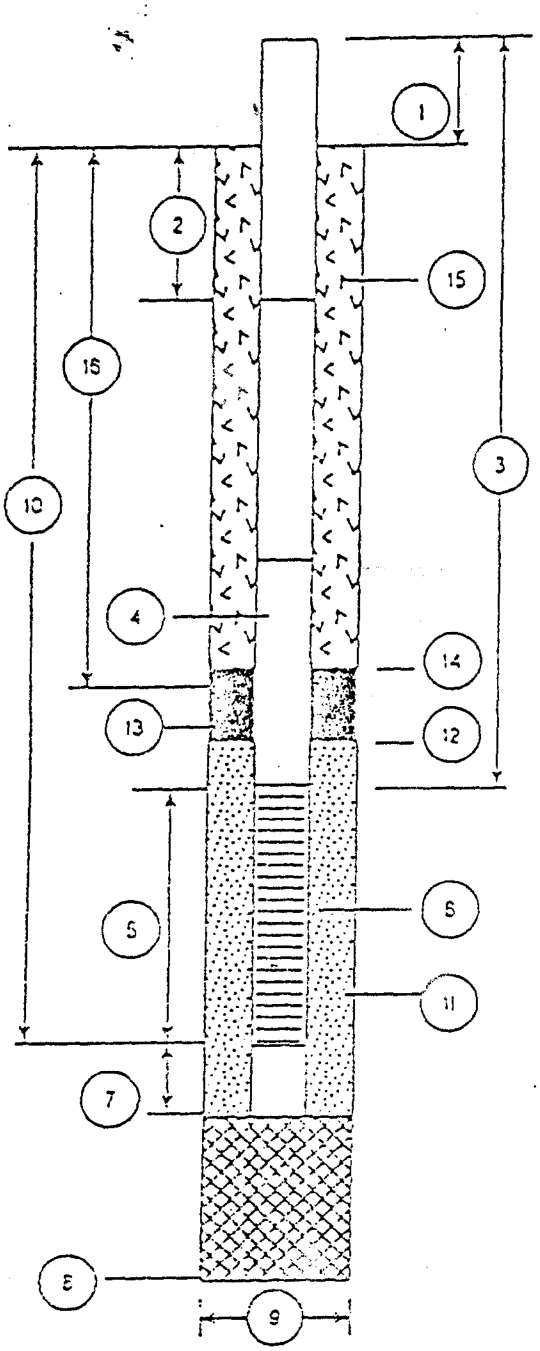
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-11-12C

DATE OF INSTALLATION: 7/6/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 9.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 59.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 65'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 64.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 250 lbs Size: 20/30
12. Depth to Top of Filter: 58'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 15 lbs
14. Depth to Top of Seal: 56'
15. Type of Grout:
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ___

COMMENTS ON INSTALLATION

WCH-IC

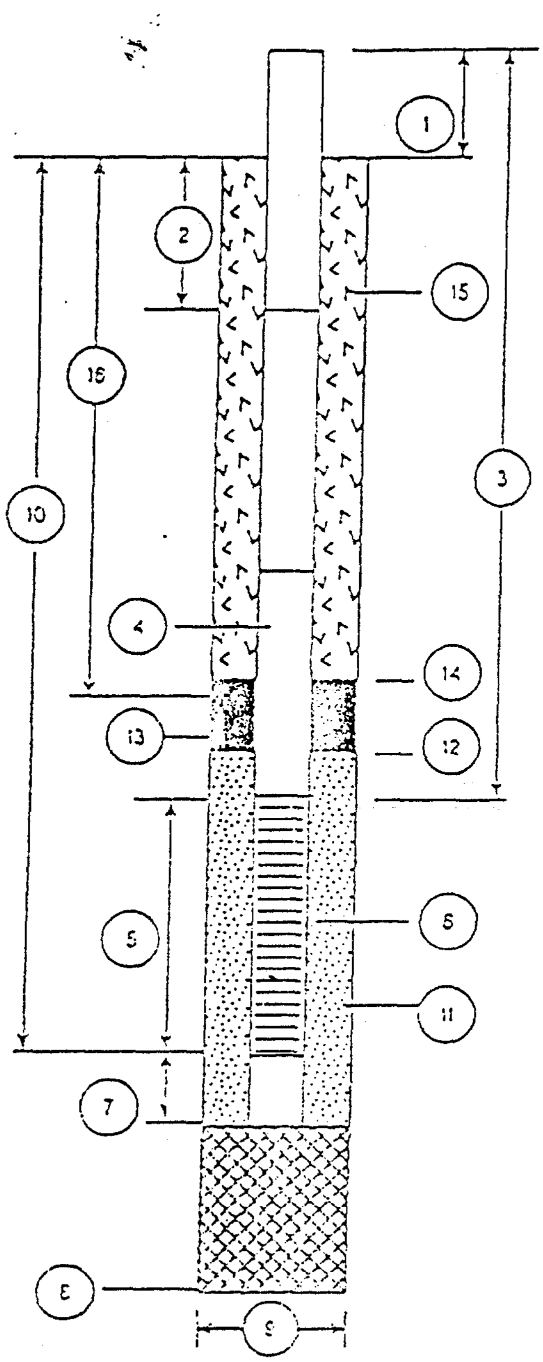
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-W-13A

DATE OF INSTALLATION: 6/26/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 2.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 12.5
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 10'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 23'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 22.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 500 lbs Size: 20/30
12. Depth to Top of Filter: 11'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 15 lbs
14. Depth to Top of Seal: 9'
15. Type of Grout:
    Grout Mixture: 360 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing:

COMMENTS ON INSTALLATION

NO-EC

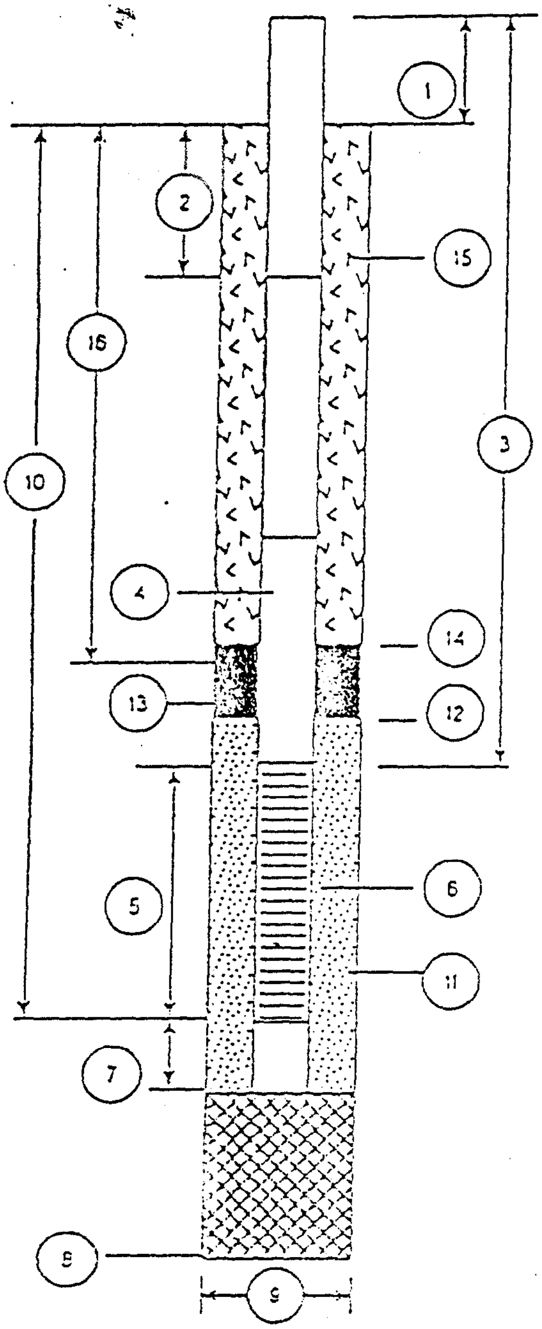
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER. OLD-41-14B

DATE OF INSTALLATION: 6/26/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 4.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 34.5
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 40'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 39.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 33'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 15 lbs.
14. Depth to Top of Seal: 31'
15. Type of Grout: ______
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

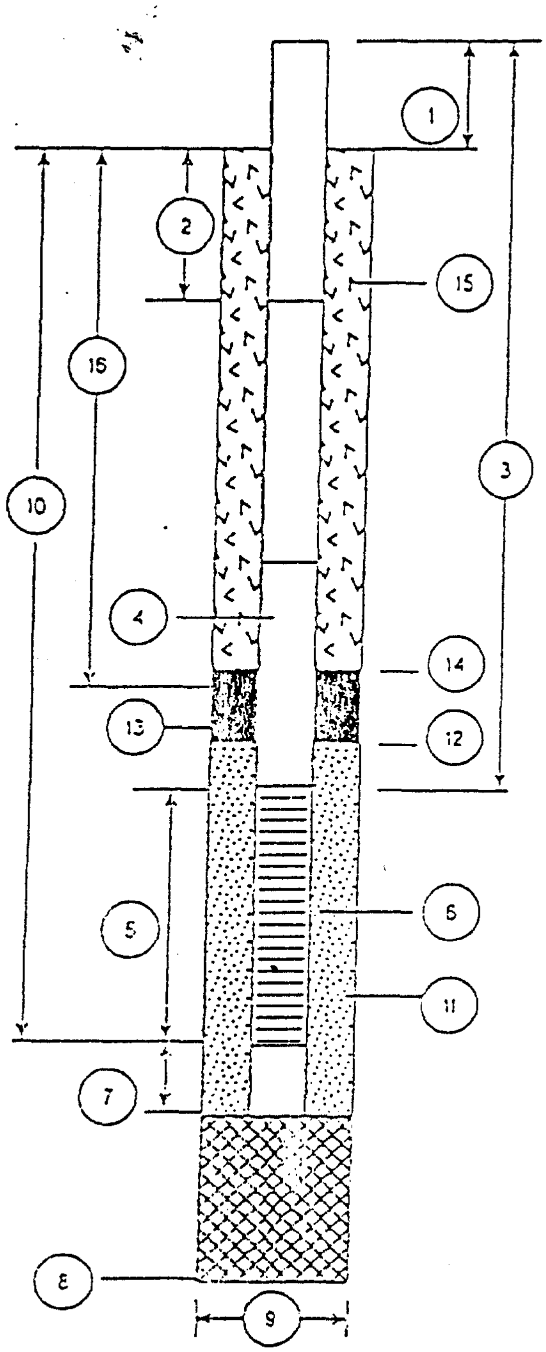
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-WI-15C

DATE OF INSTALLATION: 6/26/95



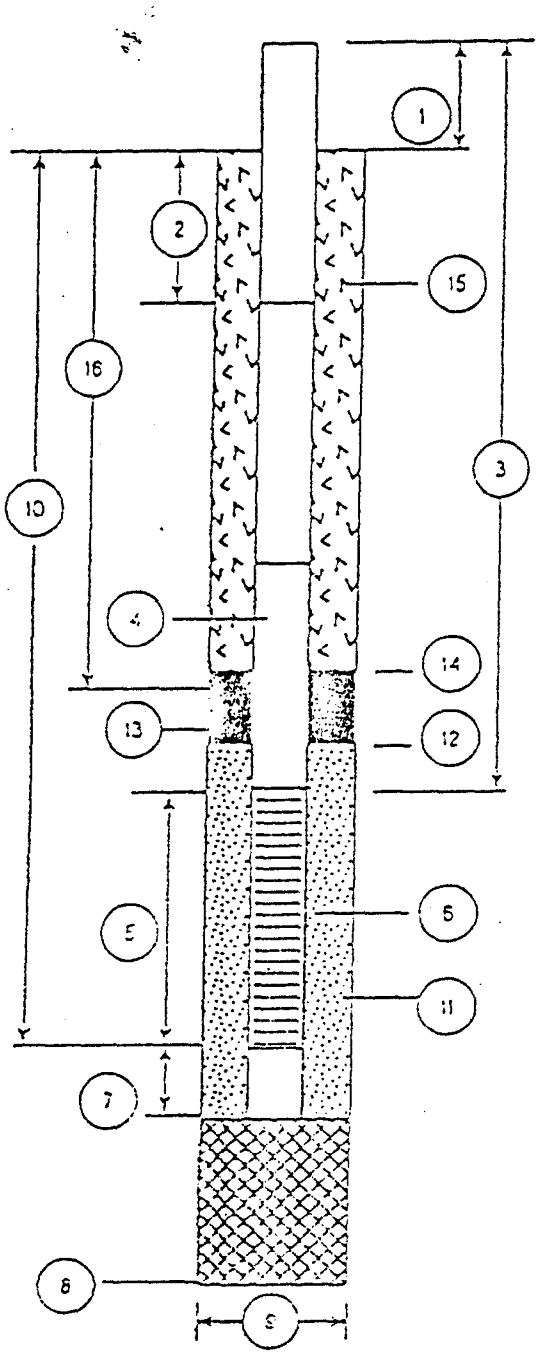
1. Height of Casing above ground: FM
2. Depth to first Coupling: 9'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 49'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 54.5'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 54'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 47'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 15 lbs
14. Depth to Top of Seal: 45'
15. Type of Grout: ______
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

FO-1C

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.



WELL CONSTRUCTION DETAIL

WELL NUMBE... OLD-U1-16A

DATE OF INSTALLATION: 7/5/95

1. Height of Casing above ground: FM
2. Depth to first Coupling: 9.5'
   Coupling Interval Depths: —
3. Total Length of Riser Pipe: 9.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 10'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 20
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 19.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 500 lbs Size: 20/30
12. Depth to Top of Filter: 8'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/15 lbs
14. Depth to Top of Seal: 6'
15. Type of Grout: ______
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 8 in. Steel Casing: ____

COMMENTS ON INSTALLATION

KO-10

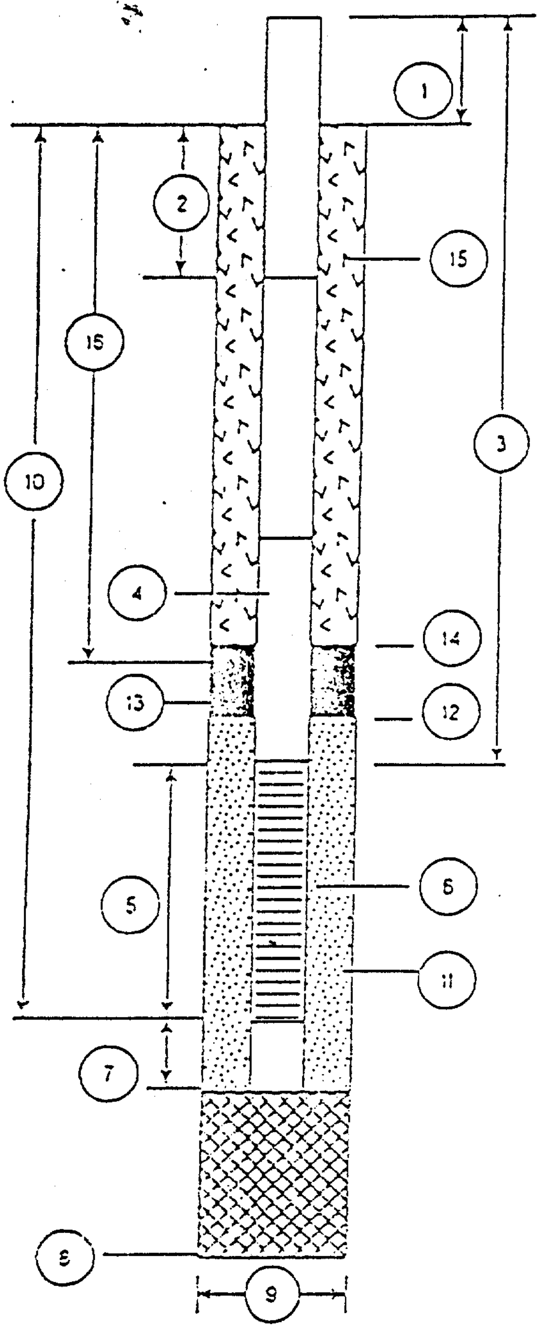
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-W-17B

DATE OF INSTALLATION: 7/5/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 9.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 29.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 35'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 34.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 28'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 15 lbs
14. Depth to Top of Seal: 26'
15. Type of Grout: ______
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water ≈ 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

KO-KC

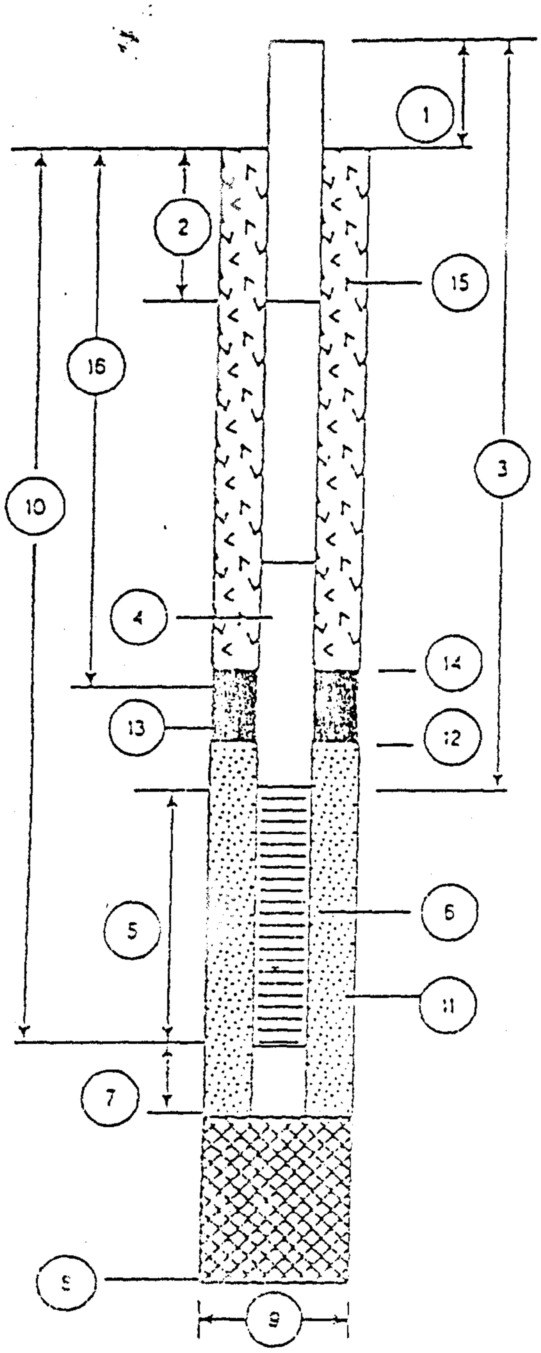
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-41-18C

DATE OF INSTALLATION: 6/30/95



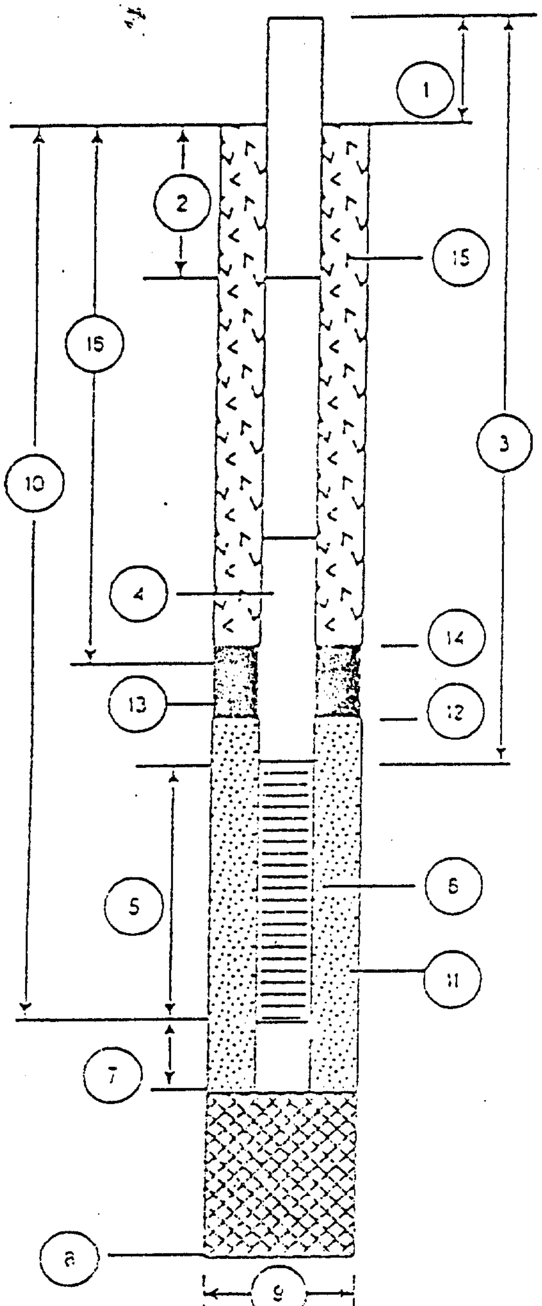
1. Height of Casing above ground: FM
2. Depth to first Coupling: 2.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 42.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6'
8. Total Depth of Boring: 48'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 47.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 41'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/15 lbs
14. Depth to Top of Seal: 39'
15. Type of Grout:
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing:

COMMENTS ON INSTALLATION

KCH-IC

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.



WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-4L-19A

DATE OF INSTALLATION: 6/29/95

1. Height of Casing above ground: FM
2. Depth to first Coupling: 2.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 12.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 10'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 23'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 22.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 16
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/15 lbs
14. Depth to Top of Seal: 14
15. Type of Grout: ______
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

YCI-IC

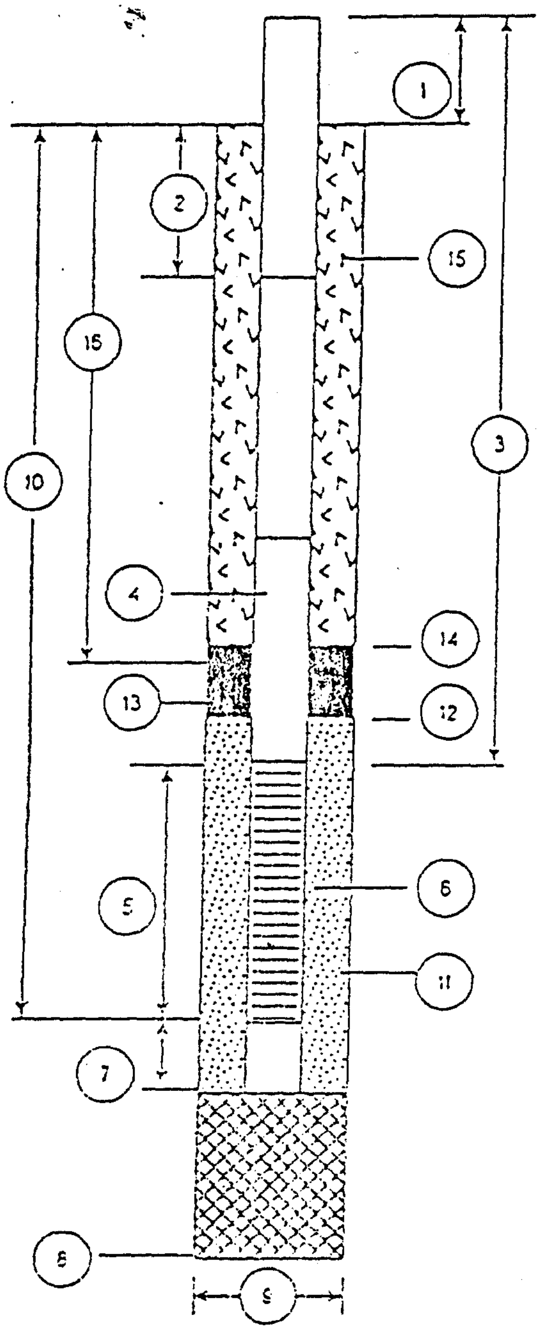
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-41-20B

DATE OF INSTALLATION: 6/29/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 9.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 29.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 35'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 34.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 28'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/15 lbs
14. Depth to Top of Seal: 26'
15. Type of Grout: ______
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

NCH-8C

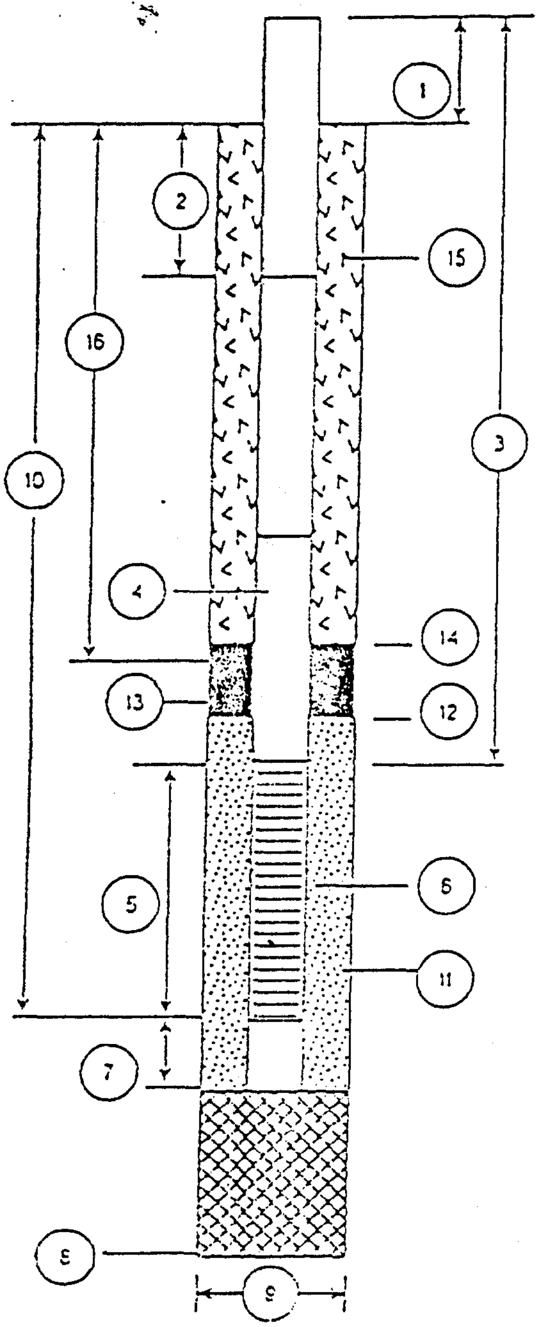
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: QLD-41-21C

DATE OF INSTALLATION: ______

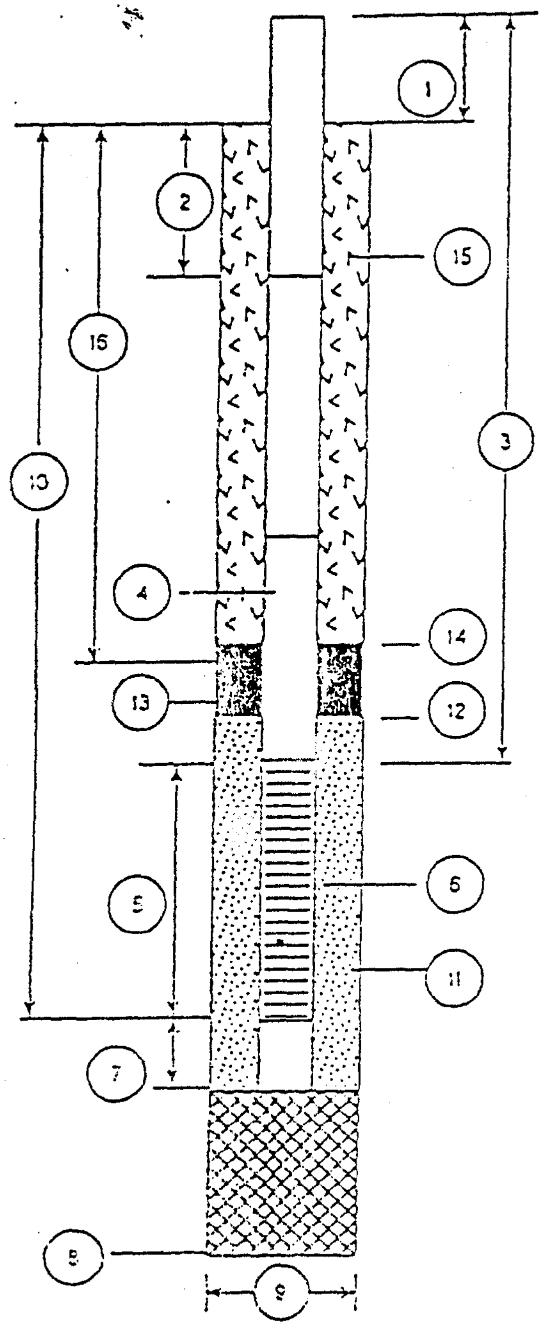


1. Height of Casing above ground: FM
2. Depth to first Coupling: 5.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 45.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 51'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 50.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 44'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/14 lbs
14. Depth to Top of Seal: 42'
15. Type of Grout: ______
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.



WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-41-22A

DATE OF INSTALLATION: 6/15/95

1. Height of Casing above ground: FM
2. Depth to first Coupling: 9.5'
   Coupling Interval Depths: —
3. Total Length of Riser Pipe: 9.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 10'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 20'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 19.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 450 lbs Size: 20/30
12. Depth to Top of Filter: 8'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/14 lbs
14. Depth to Top of Seal: 6'
15. Type of Grout: ______
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 8 in. Steel Casing: ——

COMMENTS ON INSTALLATION

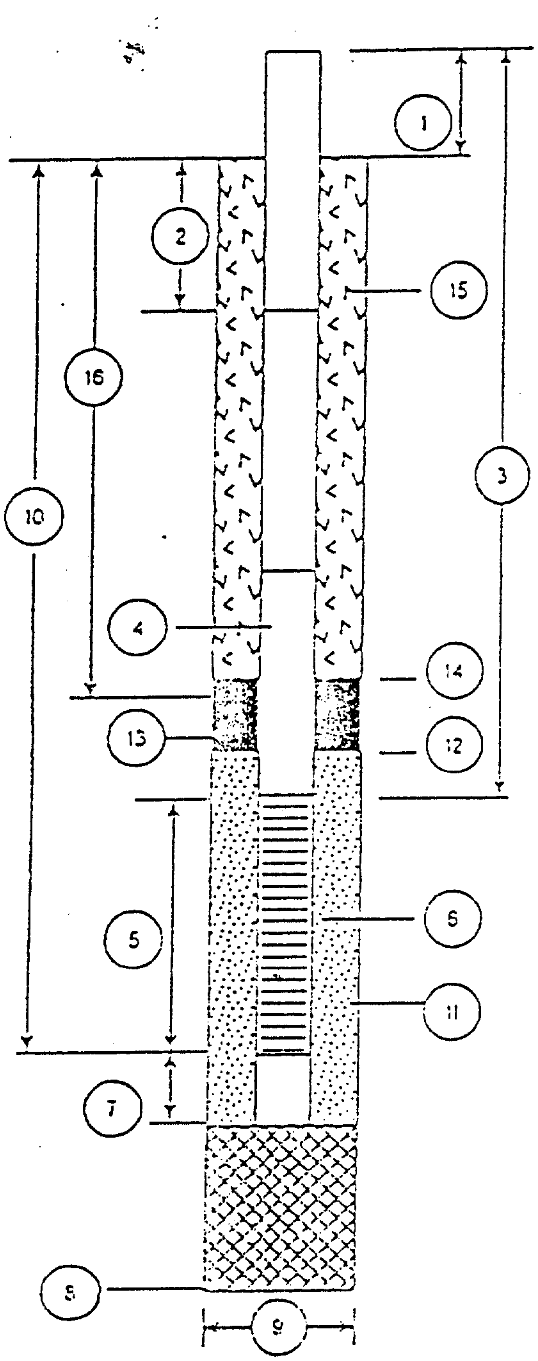
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-UI-23B

DATE OF INSTALLATION: 6/15/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 4.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 34.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 40'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 39.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 33.5'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 13 lbs
14. Depth to Top of Seal: 31.5'
15. Type of Grout: ____
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

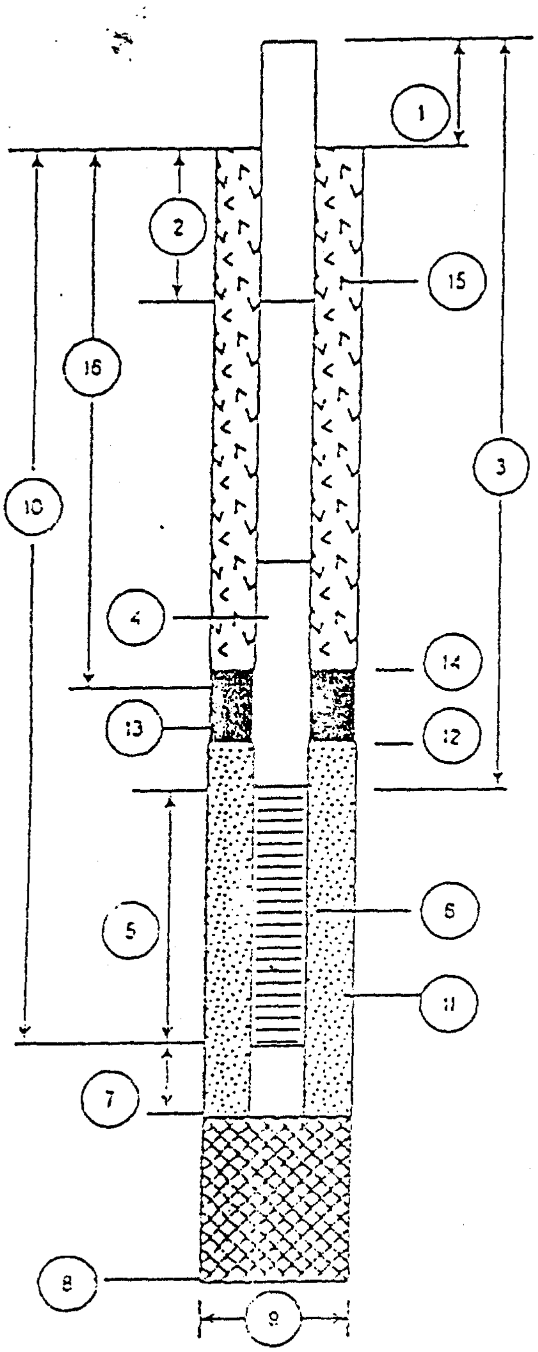
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-41-24C

DATE OF INSTALLATION: 6/16/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 4.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 64.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 70'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 69.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 400 lbs Size: 20/30
12. Depth to Top of Filter: 64.5'
13. Type of Seat 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs / 16 lbs
14. Depth to Top of Seal: 60.5'
15. Type of Grout:
    Grout Mixture: 360 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water ≈ 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing:

COMMENTS ON INSTALLATION

KD-KC

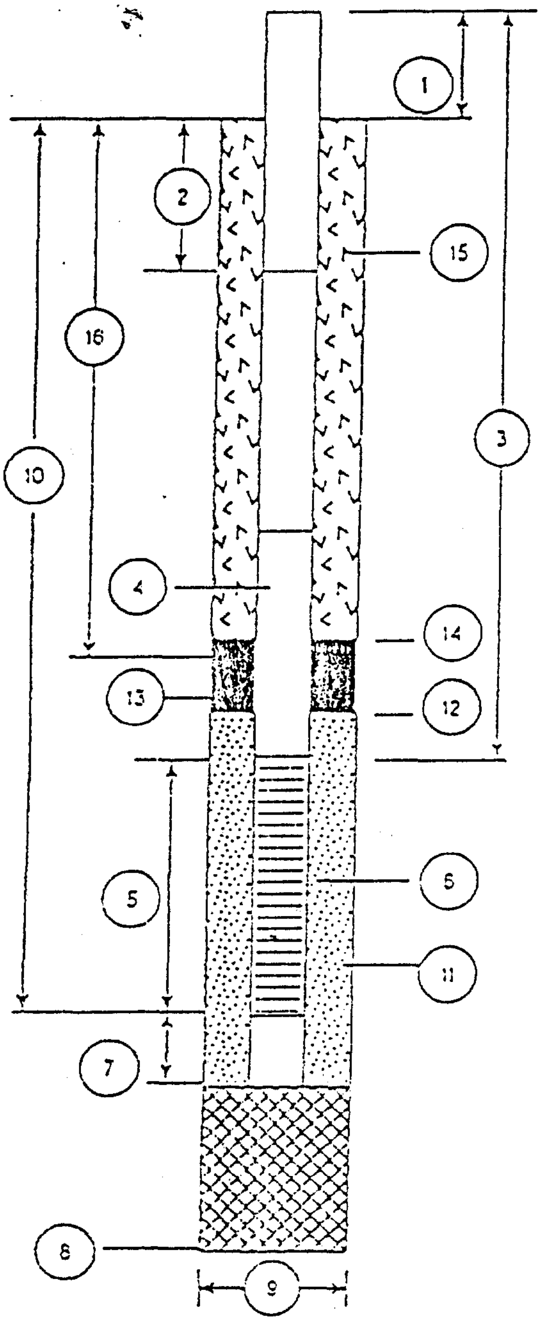
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-41-25A

DATE OF INSTALLATION: 6/13/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 9.5'

   Coupling Interval Depths: —
3. Total Length of Riser Pipe: 9.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 10'
6. Type of Screen: 2" ID Schedule 40 0.010 slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 20'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 19.5'
11. Type of Screen Filter: Silica Sand

    Quantity Used: 400 lbs Size: 20/30
12. Depth to Top of Filter: 8'
13. Type of Seat: 30/60 Silica Sand / 3/8" Bentonite Chips

    Quantity Used: 50 lbs / 15 lbs
14. Depth to Top of Seat: 6'
15. Type of Grout: ______

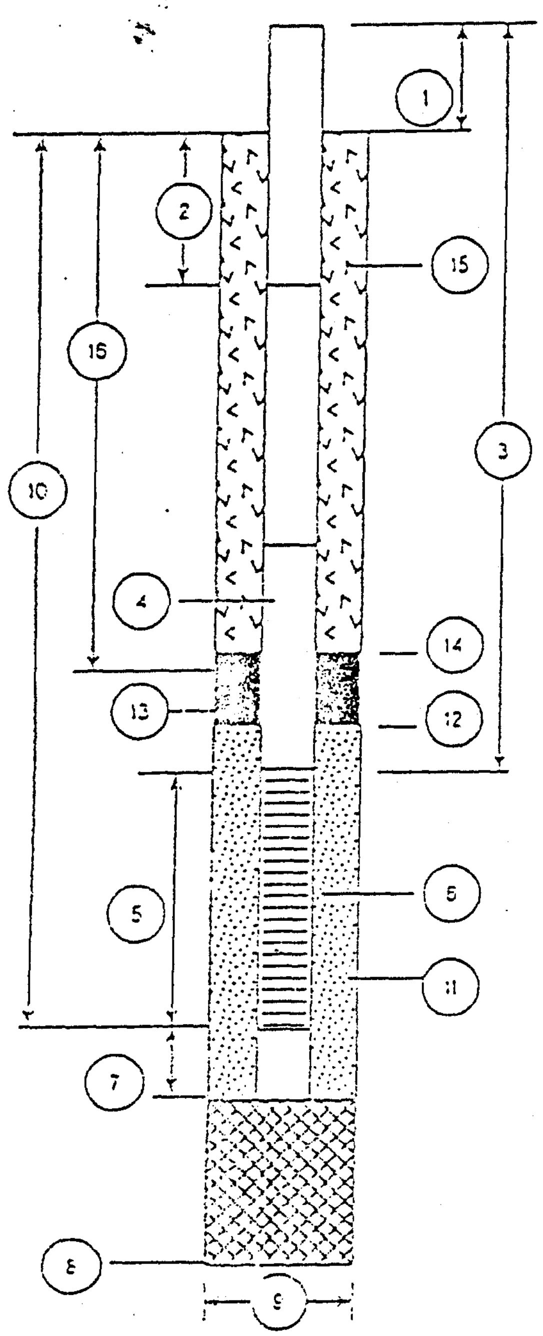
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal

    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: —

COMMENTS ON INSTALLATION

DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.



WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-41-26B

DATE OF INSTALLATION: 6/13/95

1. Height of Casing above ground: FM
2. Depth to first Coupling: 4.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 44.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 50'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 49.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 350 lbs Size: 20/30
12. Depth to Top of Filter: 42.5'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/12.5 lbs
14. Depth to Top of Seal: 40.5
15. Type of Grout: ____
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 8 in. Steel Casing: ____

COMMENTS ON INSTALLATION

NCH-3C

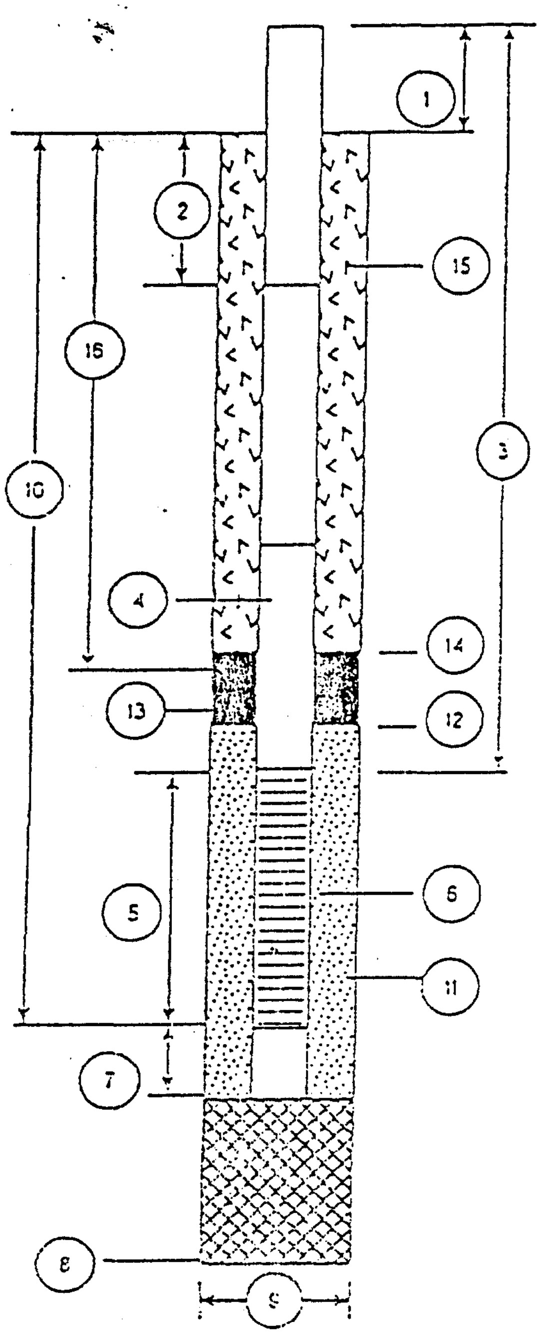
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-41-27C

DATE OF INSTALLATION: 6/12/95



1. Height of Casing above ground: FM
2. Depth to first Coupling: 7.5'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 57.5'
4. Type of Riser Pipe: 2" ID Schedule 40 PVC
5. Length of Screen: 5'
6. Type of Screen: 2" ID Schedule 40 0.010 Slot PVC
7. Length of Sump: 6"
8. Total Depth of Boring: 63'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 62.5'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 300 lbs Size: 20/30
12. Depth to Top of Filter: 56.5'
13. Type of Seal: 30/60 Silica Sand / 3/8" Bentonite Chips
    Quantity Used: 50 lbs/12.5 lbs
14. Depth to Top of Seal: 54.5'
15. Type of Grout: ______
    Grout Mixture: 300 lbs Type I Portland Cement
    12.5 lbs Bentonite gel
    12 gal of water = 40 gal
    Method of Placement: Tremie Pipe
16. Tot. Depth of 6 in. Steel Casing: ____

COMMENTS ON INSTALLATION

KCY-KC

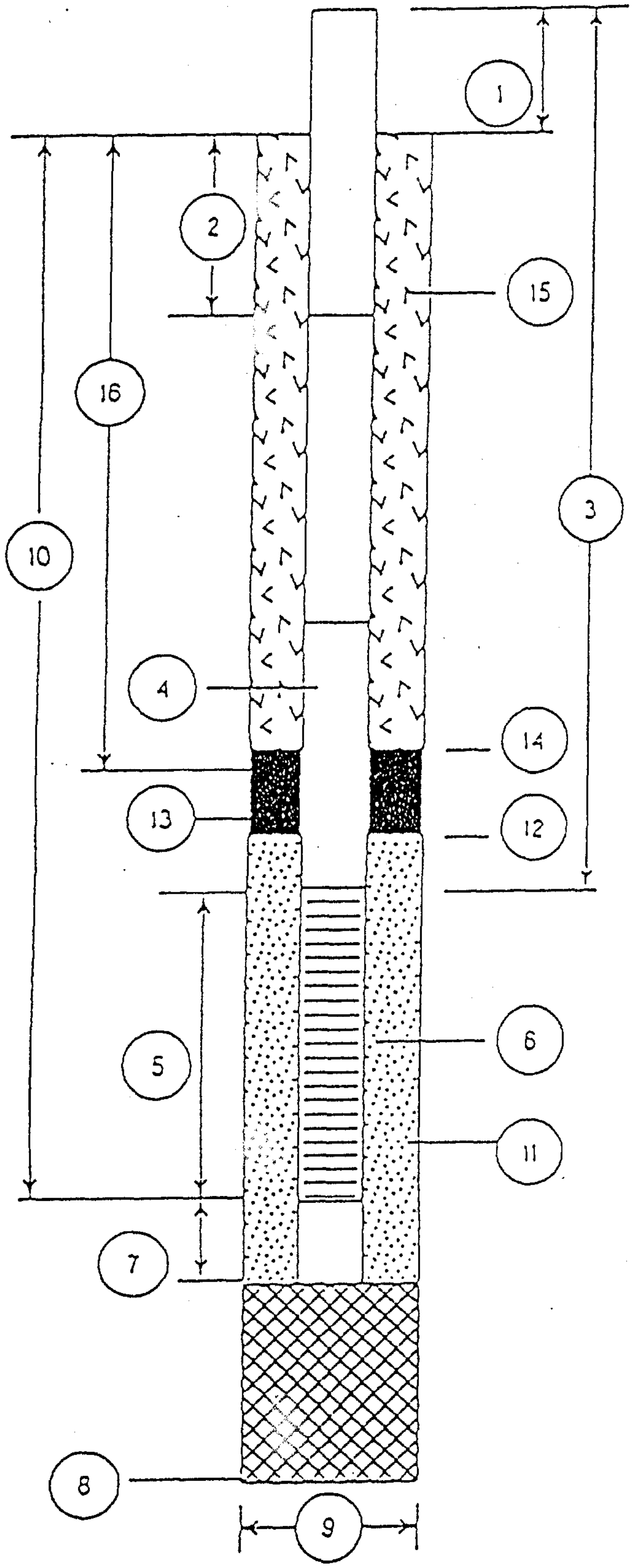
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL

WELL NUMBER: OLD-01-28B

DATE OF INSTALLATION: 7-31/96



1. Height of Casing above ground: FM
2. Depth to first Coupling: 8

   Coupling Interval Depths: 10
3. Total Length of Riser Pipe: 28
4. Type of Riser Pipe: 2" Sched 40 PVC
5. Length of Screen: 5
6. Type of Screen: 2" Sched 40
7. Length of Sump: 6"
8. Total Depth of Boring: 33'
9. Diameter of Boring: 10''
10. Depth to Bottom of Screen: 33'
11. Type of Screen Filter: Silica Sand

    Quantity Used: 450lb Size: 20/30
12. Depth to Top of Filter: 26
13. Type of Seal: bentonite chips/30/60 Sand

    Quantity Used: 35lb/50lb
14. Depth to Top of Seal: 23
15. Type of Grout: Portland cement/Bentonite

    Grout Mixture:

    Method of Placement: Tremie
16. Tot. Depth of 6 in. Steel Casing: NA

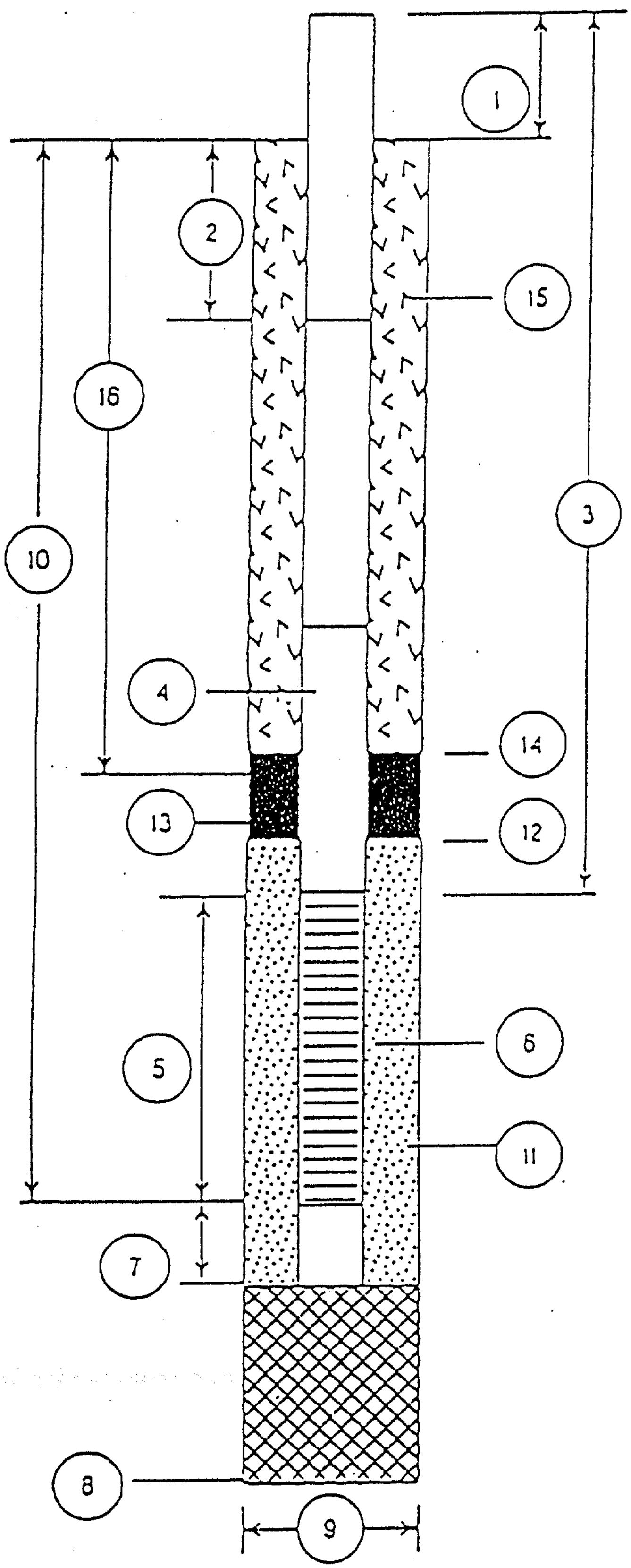
DEPARTMENT OF THE NAVY

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SC.

WELL CONSTRUCTION DETAIL -

WELL NUMBER: OLD-01-29C

DATE OF INSTALLATION: 8-1/96



1. Height of Casing above ground: FM
2. Depth to first Coupling: 10'
   Coupling Interval Depths: 10'
3. Total Length of Riser Pipe: 60'
4. Type of Riser Pipe: 2" sched 40 pvc
5. Length of Screen: 5'
6. Type of Screen: 2" sched 40 pvc 0.010 slot
7. Length of Sump: 6"
8. Total Depth of Boring: 65'
9. Diameter of Boring: 10"
10. Depth to Bottom of Screen: 65'
11. Type of Screen Filter: Silica Sand
    Quantity Used: 350 lb Size: 20/30
12. Depth to Top of Filter: 58'
13. Type of Seal: bentonite chips / 30/60 sand
    Quantity Used: 70 lb / 25 lb
14. Depth to Top of Seal: 55'
15. Type of Grout: Portland cement / bentonite gel
    Grout Mixture:
    Method of Placement: tremie
16. Tot. Depth of 6 in. Steel Casing: NA

APPENDIX F-2

MONITORING WELL DEVELOPMENT LOGS

1/2

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/19/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/11/95	Logged by: MH	Checked by: WDC
Well/Site I.D.: OLD - U1-01 ~~01~~ A	Weather: Sunny ≈ 94	Start Date: 7/11/95	Finish Date: 7/12/95
Volume of Drilling Fluid Lost (gal.) 0 ~~129~~ MM	Volume of Water in Well and Filter Pack (gal.) 8.86	Start Time: 1340	Finish Time: 1005

Installed Depth From Top of Well Casing to Bottom of Well: 14'

Initial Depth to Water (ft): 5.64' | Initial Depth to Well Bottom: 13.02'

Water Level during Initial Pumping/Purging (ft): 12.43'

Depth to Water at Termination of Pumping/Purging (ft): 5.83' | Depth to Well Bottom at Termination of Pumping/Purging (ft): 13.02'

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity mMHO	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
1343	33°	4.54	370	>200		.75
1410	30	5.57	232	>200		.75
1430	30.5	5.54	146	>200		.75
1446	30	5.81	270	>200		.75
7/12/95 ↓ 0746	27	4.26	201	>200		.75
0756	28.5	4.21	202	>200		.75

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Centrifugal pump Honda ~~WB15~~ WH15X SD000217

220 gal

Well Developer's Signature [signature]

FIGURE 4-3 EXAMPLE WELL DEVELOPMENT RECORD	SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND — PROJECT OPERATIONS PLAN NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

2/2

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: ~~U1-01-01~~ U1-01A	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft): | Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft): | Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0812	29	4.93	195	>200		.75
0829	30	5.28	202	>200		.75
0906	30	5.61	215	>200		.75
0927	30.5	5.69	222	>200		.75
0939	31	5.84	228	>200		.75
0954	31	5.74	226	>200		.75
1003	31	5.74	222	>200		.75

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

1/2

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/19/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/11/95	Logged by: MH	Checked by: WDR
Well/Site I.D.: OLD-U1-02B ~~U1-01-02~~	Weather: Sunny ~94	Start Date: 7/11/95	Finish Date: 7/11/95
Volume of Drilling Fluid Lost (gal.) 0	Volume of Water in Well and Filter Pack (gal.) 11.70	Start Time: 1340	Finish Time: 1510

Installed Depth From Top of Well Casing to Bottom of Well: 28'

Initial Depth to Water (ft): 10.72' | Initial Depth to Well Bottom: 27.94'

Water Level during Initial Pumping/Purging (ft): 15.54'

Depth to Water at Termination of Pumping/Purging (ft): 13.17 | Depth to Well Bottom at Termination of Pumping/Purging (ft): 27.95

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity μMHOS	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
1345	27.5	5.45	109	>200		4
1357	27.5	5.36	90	>200		4
1413	28	5.27	84	>200		4
1417	28	5.20	80	>200		4
1425	27	5.13	80	>200		4
1431	28	5.22	80	>200		4
1438	27	5.13	82	>200		4

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Centrifugal pump Honda WB15 SO# 888955
220 gal

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

2/2

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-01-02B ~~U1-01-07~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1454 ~~1554~~	21	5.13	78	>200		4

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3 EXAMPLE WELL DEVELOPMENT RECORD	PROJECT OPERATIONS PLAN NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

1/4

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando (OU1)	Well Installation Date and Time: 6/16/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/11/95	Logged by: MH	Checked by: [illegible]
Well/Site I.D.: ~~U-01-03~~ OLD-U1-03	Weather: Sunny ≈94	Start Date: 7/11/95	Finish Date: 7/13/95
Volume of Drilling Fluid Lost (gal.) 129	Volume of Water in Well and Filter Pack (gal.) 15.32	Start Time: 1340	Finish Time: 1029

Installed Depth From Top of Well Casing to Bottom of Well: ~~50'~~ 59'

Initial Depth to Water (ft): 19.21'

Initial Depth to Well Bottom: 58.14'

Water Level during Initial Pumping/Purging (ft): 20.34

Depth to Water at Termination of Pumping/Purging (ft): 19.0' ~~27.95~~

Depth to Well Bottom at Termination of Pumping/Purging (ft): 58.14'

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity µmhos	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
1348	26	5.98	465	>200		1.5
1403	26	5.70	160	>200		1.5
1419	26	5.58	121	>200		1.5
1437	26	5.52	101	>200		1.5
7/12/95 1455	26	5.45	92	>200		1.5
0750	25	5.57	305	>200		1.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Waterra Pump SD #001312

7/13/95 Centrifugal Honda Pump WH15X

825 gal

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

NTC_Orl.POP
MVL.07.94

2/4

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: ~~U1-01-03~~ OD-U1-03C	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0808	25	5.34	110	>200		1
0826	25	5.43	92	>200		1
0847	25	5.46	80	>200		1
0924	26	5.15	82	>200		1
0957	26	5.52	70	>200		1
1022	26	5.54	70	>200		1
1055	27	5.48	62	> 200		1

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

3/4

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-U1-03C ~~U1-01-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1118	27	5.42	62	>200		1
1138	27	5.38	60	>200		1
1208	27	5.42	60	>200		1
1252	27	5.45	58	>200		1
1350	27	5.37	61	>200		1
1435	30	5.33	58	>200		1

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

4/4)

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: ~~U1-01-03~~ OLD-U1-03C	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0835	27	5.02	60	>200		1.5
0909	27	5.23	60	184.4		1.5
0943	28	5.13	58	151.6		1.5
1003	28	5.05	57	142.3		1.5
1029	28	4.93	58	131.5		1.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

1/2

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/21/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/12/95	Logged by: MH	Checked by: WDC
Well/Site I.D.: OLD-U1-04/A ~~U2 U1-02-01~~	Weather: Sunny 90	Start Date: 7/12/95	Finish Date: 7/12/95
Volume of Drilling Fluid Lost (gal.) 0	Volume of Water in Well and Filter Pack (gal.) 7.56	Start Time: 1027	Finish Time: 1355

Installed Depth From Top of Well Casing to Bottom of Well: 21

Initial Depth to Water (ft): 14.08 | Initial Depth to Well Bottom: 20.38

Water Level during Initial Pumping/Purging (ft): 17.34

Depth to Water at Termination of Pumping/Purging (ft): | Depth to Well Bottom at Termination of Pumping/Purging (ft): 20.54

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity NMHOS	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
1030	29	5.46	80	>200		1.5
1048	28.5	5.51	72	>200		1.5
1126	32	5.39	72	>200		1.5
1148	30	5.17	70	>200		1.5
1158	30	5.35	70	>200		1.5
1207 ~~120~~ JMH	33	5.39	72	52.6		1.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Temporarily stopped pumping @ 1113 started back up @ 1125

Centrifugal Pump Honda ~~WB15 SD 888955~~ MH WH15X SD000217

150 gal

Well Developer's Signature Max Hames

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

2/2

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-UJ-04/A ~~14-02-01~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft): ~~14.31~~ ABB 7-12-95	Initial Depth to Well Bottom: 20.38 ABB 7-12-95

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft): 14.31	Depth to Well Bottom at Termination of Pumping/Purging (ft): 20.38

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1217	32	5.37	74	40.2		.5
13:10	30	5.10	68	OFFSCALE >200		.5
1324	30	5.06	65	94.2		.5
1331 ~~1341~~ mtl	30	5.16	65	23.1		.5
1340	30	5.18	65	22.1		.5
1350	30	5.13	67	38.5		.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Shut pump off at 12:31, let recharge
12:44 - PUMPING RESUMED, TURBIDITY HAS WORSENED
13:55 - PUMPING HALTED, BASED ON VISUAL ESTIMATE, APPROX. 150 GALLONS PURGED

Well Developer's Signature ______

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

1/1

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/21/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/12/95	Logged by: MH	Checked by: WRA
Well/Site I.D.: OLD-U1-05B ~~U1-02-02~~	Weather: Sunny ≃ 82	Start Date: 7/12/95	Finish Date: 7/12/95
Volume of Drilling Fluid Lost (gal.) 0	Volume of Water in Well and Filter Pack (gal.) 12.25	Start Time: ~~0800~~ 0815	Finish Time: 0915

Installed Depth From Top of Well Casing to Bottom of Well: 38'

Initial Depth to Water (ft): 16.81' | Initial Depth to Well Bottom: 37.31'

Water Level during Initial Pumping/Purging (ft): 24.30'

Depth to Water at Termination of Pumping/Purging (ft): 16.85 | Depth to Well Bottom at Termination of Pumping/Purging (ft): 37.30

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0817	27	5.24	262	>200		3.25
0829	27	5.03	118	>200		3.25
0850	27	4.91	100	56.6		3.25
0902	27	4.83	98	41.7		3.25
0914	27	4.88	95	29.6		3.25

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

150gal rem.
Centrifugal Pump Honda WH15X SD000217
150gal

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

1 of 3

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/20/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/12/95	Logged by: MK	Checked by: [illegible]
Well/Site I.D.: OLD-U1-06C ~~U1-02-03~~	Weather: Sunny 90	Start Date: 7/12/95	Finish Date: 7/13/95
Volume of Drilling Fluid Lost (gal.) 135	Volume of Water in Well and Filter Pack (gal.) 15.75	Start Time: 1030	Finish Time: 1328

Installed Depth From Top of Well Casing to Bottom of Well: 59

Initial Depth to Water (ft): 16.89 | Initial Depth to Well Bottom: 58.41

Water Level during Initial Pumping/Purging (ft): 20.82

Depth to Water at Termination of Pumping/Purging (ft): 16.91 | Depth to Well Bottom at Termination of Pumping/Purging (ft): 58.41

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1039	27	6.27	740	>200		1.75
1102	28	~~4.58~~ 5.69 MK	365	>200		1.75
1130	29	5.59	330	>200		1.75
1228	30	5.34	266	>200		1.5
14:10	30	5.16	208	>200		1.5
1445	30	5.07	203	>200		1.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Centrifugal Pump Honda WB15 SD 888955
770 gal

Well Developer's Signature ______

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

2 of 3

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-U1-06C ~~U1-02-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time: -

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0837	27.5	4.89	193	>200		1.5
0913	27.5	4.99	188	196.0		1.5
1001	28	4.88	182	>200		1.5
1037	28	4.75	180	171.3		1.5
1115	27	4.76	123	151.9		1.5
1157	27	4.76	173	140.2		1.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

3 of 3

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-U1-06C ~~U1-02-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1240	27	4.89	170	125.9		1.5
1257	27	4.86	169	122.7		1.5
1328	27	4.97	179	118.1		1.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

1of 1

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: ~~6/21, 22/95~~ 6/22/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/13/95	Logged by: MH	Checked by: WQC
Well/Site I.D.: OLD-U1-07A ~~U1-03-01~~	Weather: Sunny ≈ 89	Start Date: 7/13/95	Finish Date: 7/13/95
Volume of Drilling Fluid Lost (gal.) 0	Volume of Water in Well and Filter Pack (gal.) 6.36'	Start Time: 1050	Finish Time: 1136

Installed Depth From Top of Well Casing to Bottom of Well: 23

Initial Depth to Water (ft): 16.91'	Initial Depth to Well Bottom: 22.21'

Water Level during Initial Pumping/Purging (ft): 19.81

Depth to Water at Termination of Pumping/Purging (ft): 16.98	Depth to Well Bottom at Termination of Pumping/Purging (ft): 22.19

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1056	25	4.62	184	>200		3
1115	27	4.68	192	26.5		3
1123	25	4.66	183	10.6		3
1132	25	4.71	180	17.5		3
1136	26	4.81	182	6.33		3

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Stopped pumping at 1137
Filled 3 drums (165 gal)

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

1 of 1

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/22/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7-13-95 1148	Logged by: MH	Checked by: [illegible]
Well/Site I.D.: OCD-U1-08B ~~U1-03-02~~	Weather: Sunny ~93	Start Date: 7/13/95	Finish Date: 7/13/95
Volume of Drilling Fluid Lost (gal.) 0	Volume of Water in Well and Filter Pack (gal.) 12.87'	Start Time: 1148	Finish Time: 1313

Installed Depth From Top of Well Casing to Bottom of Well: 42'

Initial Depth to Water (ft): 17.04 | Initial Depth to Well Bottom: 41.27'

Water Level during Initial Pumping/Purging (ft): 23.48'

Depth to Water at Termination of Pumping/Purging (ft): 17.25 | Depth to Well Bottom at Termination of Pumping/Purging (ft): 41.27'

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1208	26	5.24	202	>200		2.5
1226	26	5.29	210	>200		2.5
1244	26	5.16	181	117.0		2.5
1253	26	5.14	181	>200		2.5
1302	26	5.17	180	85.1		2.5
1310	26.5	5.21	180	70.8		2.5
1313	26	5.23	180	72.9		2.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

275 gal

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

1/3

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/21/95 - 6/22/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/13/95	Logged by: MH	Checked by: MDQ
Well/Site I.D.: OLD-U1-09C ~~U1-03-03~~	Weather: Sunny ≈ 84	Start Date: 7/13/95	Finish Date: 7/18/95
Volume of Drilling Fluid Lost (gal.) 192	Volume of Water in Well and Filter Pack (gal.) 15.45	Start Time: 0820	Finish Time: ~~1029~~ 0908 MH 7/13/95

Installed Depth From Top of Well Casing to Bottom of Well: 58

Initial Depth to Water (ft): 17.40 | Initial Depth to Well Bottom: 57.11

Water Level during Initial Pumping/Purging (ft): ~~23.49~~ 24.70

Depth to Water at Termination of Pumping/Purging (ft): 17.23 | Depth to Well Bottom at Termination of Pumping/Purging (ft): 58.20

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0825	26	6.13	390	>200		1
0932	26	5.80	294	>200		1
1010	25.5	5.50	254	>200		1
1101	25	5.40	219	>200		1
1145	25	5.32	206	>200		1
1216	25.5	5.33	200	>200		1

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Waterra pump SD# 001312
Honda WB 15 SD 888955
880 gal

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

2/3

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-VI-09C ~~VI-03-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

	Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
	1258	25.5	5.29	195	>200		1
	1428	25.5	5.56	212	66.2		1
7/14/95	0930	26	5.25	202	>200		1
	1007	26	5.34	197	44.5		1
	1041	26.5	5.45	190	28.6		1
	1119	27	5.40	218	91.5		1

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

1145 Pump ran out of gas -> increase in NTU

Well Developer's Signature ______________________

FIGURE 4-3 EXAMPLE WELL DEVELOPMENT RECORD	PROJECT OPERATIONS PLAN NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-SI-09C ~~U1-03-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

	TIME	TEMP.	pH	Conductivity	Approximate Pumping Rate (gal/min)	Turbid NTU
BEGINNING OF WELL DEVELOPMENT	1247	28	5.37	232	1	23.
	1330	29	5.26	188	1	23.
	1427	28	5.48	180	1	14.
	1440	27	5.48	262	1	15
7/18/95	0822	28	5.39	238	1.5	39
	0836	29	5.33	232	1.5	43
END OF WELL DEVELOPMENT	0852	29	5.32	227	1.5	32
	0906	29	5.29	226	1.5	26

NOTES: (Include physical character of removed water, type & size of pump, volume of water removed.)

1430 Heavy rain

Well Developer's Signature ______________________

1/1

WELL DEVELOPMENT RECORD

Project: BRAC NTC ORlando	Well Installation Date and Time: 7-7/95 0937		Project No. 08519.70
Client: NAVY / OOL	Well Development Date and Time: 7-21/95 00:37	Logged by: WDO	Checked by:
Well/Site I.D.: OLD-11-10A ~~V1-04-01~~	Weather:	Start Date: 7/21/95	Finish Date: 7/21/95
Volume of Drilling Fluid Lost (gal.) ø	Volume of Water in Well and Filter Pack (gal.) 7.51	Start Time: 0925	Finish Time: 1013

Installed Depth From Top of Well Casing to Bottom of Well: 23'

Initial Depth to Water (ft): 16.69

Initial Depth to Well Bottom: 22.95

Water Level during Initial Pumping/Purging (ft): 20.55

Depth to Water at Termination of Pumping/Purging (ft): 16.80'

Depth to Well Bottom at Termination of Pumping/Purging (ft): 22.95

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0930	27.5	4.80	118	185.5	50 gal/rem.	1.5gpm
0935	27	4.79	119	89.2		1.5gpm
0945	27	4.93	120	44.2		1.5gpm
0950	27	4.91	115	27.3		1.5gpm
0955	27	4.87	112	118.4		1.5gpm
1002	27	4.92	110	5.08		1.5gpm
1007	27	4.92	115	16.02		1.5gpm
1012	27	4.90	112	5.24		

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

centrifugal pump
clear
110 gal

Well Developer's Signature William D. Olsen

FIGURE 4-3 EXAMPLE WELL DEVELOPMENT RECORD	SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND	PROJECT OPERATIONS PLAN NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

1/2

WELL DEVELOPMENT RECORD

Project: OUL	Well Installation Date and Time: 7-25/95 1200		Project No. 0859.70
Client: WAUY	Well Development Date and Time: 7-28/7-31 03:15	Logged by: WDO	Checked by:
Well/Site I.D.: OLD-VI-11B ~~VI-04-02~~	Weather: Partly cloudy 88°	Start Date: 7-28/95	Finish Date: 7-31/95
Volume of Drilling Fluid Lost (gal.) 100gal	Volume of Water in Well and Filter Pack (gal.) 13.22	Start Time: 0845	Finish Time: 0857

Installed Depth From Top of Well Casing to Bottom of Well: 40'

Initial Depth to Water (ft): 15.52' | Initial Depth to Well Bottom: 39.55

Water Level during Initial Pumping/Purging (ft): 16.39'

Depth to Water at Termination of Pumping/Purging (ft): 15.17 | Depth to Well Bottom at Termination of Pumping/Purging (ft): 39.55

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0900	26.5	5.35	160	>200		3gPM
0920	27.0	5.25	123	46.4		2.5gpm
0945	27.0	5.15	130	34.7		2.5gpm
1010	27.0	5.10	120	23.2		2.5gpm
1035	27.0	5.15	119	13.88		2.5gpm
1100	27.0	4.98	112	14.21		2.5gpm

2.72
10.5
13.22

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

water initially very turbid, med brown
Cent. Pump
375gal rem 7-28
550 gal total
water clear

Well Developer's Signature [signature]

FIGURE 4-3 EXAMPLE WELL DEVELOPMENT RECORD	SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND	PROJECT OPERATIONS PLAN NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

2/2

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: ~~OLD-04-02~~ OLD-UL-11B	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft): Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft): Depth to Well Bottom at Termination of Pumping/Purging (ft):

7-31

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0810	26.0	5.02	120	35.0		2.5gpm
0825	26.0	5.09	110	43.9		3.0gpm
0837	26.0	5.06	109	28.2		2.5gpm
0844	26.0	5.02	105	17.65		2.5gpm
0851	26.0	5.01	105	14.89		2.5gpm
0857	26.0	5.03	104	13.61		2.5gpm

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ____________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project: NTC ORLANDO OU 1	Well Installation Date and Time: 7-6/95 1925		Project No. 08519-70
Client: South Div.	Well Development Date and Time: 7-21/95	Logged by: JMN	Checked by: WDO
Well/Site I.D.: OD-01-12C ~~U1-04-05~~	Weather:	Start Date: 7/21/95	Finish Date: 7-21/95
Volume of Drilling Fluid Lost (gal.) 630	Volume of Water in Well and Filter Pack (gal.) 16.78	Start Time: 0830	Finish Time: 1424

Installed Depth From Top of Well Casing to Bottom of Well: 65'

Initial Depth to Water (ft): 16.59	Initial Depth to Well Bottom: 64.29

Water Level during Initial Pumping/Purging (ft): 16.65'

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1040	26	5.18	158	>200		2
1212	28.5	5.47	178	97.2		2.5
1300	28	5.16	155	63.9		2.5
1347	28.5	5.17	153	46.6		2.5
1358	28.5	5.06	151	39.2		2.5
1415	28.5	4.99	150	36.4		2.5
1424	27.0	4.98	149	37.2		2.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Watera SD# 001312

1100 switched to Honda WH15X SD 000217

550 gal

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU-1	Well Installation Date and Time: 6-26-95		Project No. 08519.70
Client: NAVY	Well Development Date and Time: 7/17/95	Logged by: JMN	Checked by: WDB
Well/Site I.D.: OLD-01-13A ~~U1-05-01~~	Weather: Rainy ≈ 80	Start Date: 7/17/95	Finish Date: 7/17/95
Volume of Drilling Fluid Lost (gal.) 0	Volume of Water in Well and Filter Pack (gal.) 8.18	Start Time: 0758	Finish Time: 0906

Installed Depth From Top of Well Casing to Bottom of Well: 23.0'

Initial Depth to Water (ft): 16.41'

Initial Depth to Well Bottom: 23.23'

Water Level during Initial Pumping/Purging (ft): 18.62'

Depth to Water at Termination of Pumping/Purging (ft): 16.49'

Depth to Well Bottom at Termination of Pumping/Purging (ft): 23.23

	TIME	TEMP.	pH	Conductivity	Approximate Pumping Rate (gal/min)	Turbidity NTU
BEGINNING OF WELL DEVELOPMENT	0825	25.5	4.73	119	3	40.5
	0835	25.5	4.79	115	3	5
	0843	25.5	4.98	113	3	48.
	0850	25.5	4.98	117	3	10.
	0852	25.5	5.00	112	3	7.
END OF WELL DEVELOPMENT	0854	25.5	4.95	113	3	20.
	0856	25.5	4.96	113	3	13.
	0859	25.5	4.95	114	3	8.

NOTES: (Include physical character of removed water, type & size of pump, volume of water removed.)

Honda WB15 SD 888955

190 gal

Well Developer's Signature John Nool

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU-1	Well Installation Date and Time: 6/26/95 1445		Project No. 08519.70
Client: NAVY	Well Development Date and Time:	Logged by: JMN	Checked by: WDQ
Well/Site I.D.: OLD-U1-14B ~~U1-05-02~~	Weather: Cloudy ≈ 80°	Start Date: 7/18/95	Finish Date: 7/18/95
Volume of Drilling Fluid Lost (gal.) Ø	Volume of Water in Well and Filter Pack (gal.) 12.74	Start Time: 0936	Finish Time: 1025

Installed Depth From Top of Well Casing to Bottom of Well: 40.0'

Initial Depth to Water (ft): 16.06'

Initial Depth to Well Bottom: 39.51'

Water Level during Initial Pumping/Purging (ft): 17.54'

Depth to Water at Termination of Pumping/Purging (ft): 16.07'

Depth to Well Bottom at Termination of Pumping/Purging (ft): 39.29'

	TIME	TEMP.	pH	Conductivity	Approximate Pumping Rate (gal/min)	Turb
BEGINNING OF WELL DEVELOPMENT	0938	27	5.09	181	3	>20
	0940	26.5	5.10	180	3	>20
	0944	26.5	5.10	181	4	>20
	0947	26.5	5.02	169	4	>20
	0952	26.5	5.10	180	4	84
END OF WELL DEVELOPMENT	0955	26.5	5.11	178	4	90.
	1014	26.0	5.13	180	4	30.

NOTES: (Include physical character of removed water, type & size of pump, volume of water removed.)

Honda WH 15 x SD 000217

165 gal

Well Developer's Signature John Nash

2 of 2

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: ~~OLD-01-14B~~ ~~U1-05-07~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1021	26	5.09	178	16.3		3
1024	26	5.09	179	14.5		3

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Turbidity was low but water had yellow tint

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU-1	Well Installation Date and Time: 6/26/95 0809		Project No. 8519.20
Client: Navy	Well Development Date and Time: 7/14/95	Logged by: JMN	Checked by: WDQ
Well/Site I.D.: OLD-U1-15C ~~U1-05-03~~	Weather: SUNNY ≈ 84	Start Date: 7/14/95	Finish Date: 7/18/95
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.) 13.3	Start Time: 1430	Finish Time: 1005

Installed Depth From Top of Well Casing to Bottom of Well: ~~53.86'~~ JMN 54.5'

Initial Depth to Water (ft): 16.23'	Initial Depth to Well Bottom: 53.86'

Water Level during Initial Pumping/Purging (ft): 17.98'

Depth to Water at Termination of Pumping/Purging (ft): 16.10'	Depth to Well Bottom at Termination of Pumping/Purging (ft): 53.86'

	TIME	TEMP.	pH	Conductivity	Approximate Pumping Rate (gal/min)	Turbid. NTU
BEGINNING OF WELL DEVELOPMENT	0853	25.5	5.37	148		>20
	1023	26	5.29	173		>2
	1115	26.5	~~5.57~~ 5.20 WDQ	168		>2
7/14/95	1300	27	5.16	167		>20
7/17/95	0826	26.5	4.91	124		138
END OF WELL DEVELOPMENT	0901	26.5	5.01	~~126.9~~ 165		126

NOTES: (Include physical character of removed water, type & size of pump, volume of water removed.)

Waterra SD 001312
Honda WB 15 SP 888955

715 gal

Well Developer's Signature John Nash

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OCD-01-15C ~~01-05-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

7/18/95	TIME	TEMP.	pH	Conductivity	Approximate Pumping Rate (gal/min)	Turbidi
BEGINNING OF WELL DEVELOPMENT	0843	30	5.09	189	.75	89.
	0903	30.5	5.12	185	.75	[illegible]
	0925	28.5	4.99	171	.75	63.
	0948	29	5.03	168	.75	69.
	0959	29	5.02	168	.75	89.
END OF WELL DEVELOPMENT						

NOTES: (Include physical character of removed water, type & size of pump, volume of water removed.)

Well Developer's Signature ______________________

1/1

WELL DEVELOPMENT RECORD

Project: OU1- NTC Orlando	Well Installation Date and Time: 7-5/95 1145		Project No. 08519-70
Client: South div	Well Development Date and Time: 7-18/95 0821	Logged by: WDO	Checked by:
Well/Site I.D.: OLD-U1-16A ~~U1-06-01~~	Weather: 85°, humid, overcast	Start Date: 7-18/95	Finish Date: 7-18/95
Volume of Drilling Fluid Lost (gal.) NA	Volume of Water in Well and Filter Pack (gal.) 6.89	Start Time: 0755	Finish Time: 0821

Installed Depth From Top of Well Casing to Bottom of Well: 20'

Initial Depth to Water (ft): 13.89'

Initial Depth to Well Bottom: 19.63'

Water Level during Initial Pumping/Purging (ft): 17.70

Depth to Water at Termination of Pumping/Purging (ft): 14.12

Depth to Well Bottom at Termination of Pumping/Purging (ft): 19.64

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0755	24.5	4.95	119	>200		3
0807	25	4.94	137	59.4		
0811	24.5	4.89	118	44.0		
0814	24.5	4.89	111	44.2		
0817	24.5	4.89	115	30.0		
0821	24.5	4.83	114	27.3		

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

≈30 gal removed
water clear w/ brown color
centrifugal pump

Well Developer's Signature Willa D. Olsen

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

1/1

WELL DEVELOPMENT RECORD

Project: NTC Orlando OU1	Well Installation Date and Time: 7-5/95 1145		Project No. 08519-70
Client: South Div	Well Development Date and Time: 7-18/95 01:15	Logged by: MDO	Checked by:
Well/Site I.D.: ~~01-00-02~~ OLD-U1-17B	Weather: 85°, humid, mostly cloudy	Start Date: 7-18/95	Finish Date: 7-18/95
Volume of Drilling Fluid Lost (gal.) N/A	Volume of Water in Well and Filter Pack (gal.) 10.54	Start Time: ~~0740~~ 0845	Finish Time: 1000

Installed Depth From Top of Well Casing to Bottom of Well: 35'

Initial Depth to Water (ft): 13.93 | Initial Depth to Well Bottom: 34.33

Water Level during Initial Pumping/Purging (ft): 19.72

Depth to Water at Termination of Pumping/Purging (ft): 13.90 | Depth to Well Bottom at Termination of Pumping/Purging (ft): 34.33

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0845	30	5.07	190	7200		3gpm
0920	26.5	5.30	220	20.7		1.5gpm
0930	26.5	5.30	210	14.35		1.5gpm
0940	26.0	5.27	202	7.39		1.5gpm
0950	26.5	5.36	201	6.46		1.5gpm WL=16.70'
1000	26.0	5.27	~~200~~ 198	5.38		1.5gpm

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

clear, lt brown tint
centrifugal pump
150gal removed

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

1/1

WELL DEVELOPMENT RECORD

Project: NTC ORLANDO OU+	Well Installation Date and Time: 6-30/95 1745		Project No. 08519-70
Client: South DIV	Well Development Date and Time: 7-21/95	Logged by: JMW	Checked by: WDD
Well/Site I.D.: OLD-VI-18C ~~01-06-03~~	Weather: Overcast ≈ 82°	Start Date: 7/21/95	Finish Date: 7-21/95
Volume of Drilling Fluid Lost (gal.) 400	Volume of Water in Well and Filter Pack (gal.) 14.47	Start Time: 0810	Finish Time: 1426

Installed Depth From Top of Well Casing to Bottom of Well: 48'

Initial Depth to Water (ft): 13.55'

Initial Depth to Well Bottom: 47.35'

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):

Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1130	28.5	5.44	104	142.0		JMN ~~.75~~ 1.5
1205	28	5.44	103	96.9		JMN ~~.75~~ 1.5
1240	28	5.45	108	67.8		JMN ~~.75~~ 1.5
1426	27.5	5.16	99	62.2		1.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

First reading taken after 240 gal pumped out

550 gal

Well Developer's Signature ______

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

1 of 1

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU-1	Well Installation Date and Time: 6/29/95 1035		Project No. 08519.70
Client: NAVY	Well Development Date and Time:	Logged by: JMN	Checked by: MWD
Well/Site I.D.: OLD-U1-1 9A ~~U1-07-01~~	Weather: Cloudy ≈ 85°	Start Date: 7/18/95	Finish Date: 7/18/95
Volume of Drilling Fluid Lost (gal.) ∅	Volume of Water in Well and Filter Pack (gal.) 8.34	Start Time: 1158	Finish Time: 1225

Installed Depth From Top of Well Casing to Bottom of Well: 23.0'

Initial Depth to Water (ft): 15.43' | Initial Depth to Well Bottom: 22.38

Water Level during Initial Pumping/Purging (ft): 17.62'

Depth to Water at Termination of Pumping/Purging (ft): 15.55' | Depth to Well Bottom at Termination of Pumping/Purging (ft): 22.65'

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1200	25	5.50	218	>200		3
1210	25.5	5.70	222	>200		1.5
1217	25	5.71	220	54.7		4
1219	25	5.73	220	31.8		4
1221	25	5.75	220	25.5		5
1223	25	5.75	219	15.0		5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Honda WH 15X SD 000217.

Low Turbidity with a brown tint

145 gal

Well Developer's Signature John Nash

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

1 of 1

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU-1	Well Installation Date and Time: 6/29/95 1250		Project No. 08519.70
Client: NAVY	Well Development Date and Time:	Logged by: JMN	Checked by: [illegible]
Well/Site I.D.: OLD-01-20B ~~01-07-02~~	Weather: Cloudy ≈ 84'	Start Date: 7/18/95	Finish Date: 7/18/95
Volume of Drilling Fluid Lost (gal.) Ø	Volume of Water in Well and Filter Pack (gal.) 12.01	Start Time: 1055	Finish Time: 1136

Installed Depth From Top of Well Casing to Bottom of Well: 35.0'

Initial Depth to Water (ft): 15.27 | Initial Depth to Well Bottom: 34.33

Water Level during Initial Pumping/Purging (ft): 21.24'

Depth to Water at Termination of Pumping/Purging (ft): 15.36 | Depth to Well Bottom at Termination of Pumping/Purging (ft): 34.33'

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1056	26	5.66	182	>200		4
1107	26	5.77	200	>200		4
1112	26	5.78	198	124.6		4
1120	26	5.79	191	115.4		4
1127	25.5	5.64	187	38.4		4
1130	25	5.69	188	24.7		4
1134	25	5.70	187	18.6		4

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Honda WH 15X SD 000217

Water had a yellow tint

220 gal

Well Developer's Signature John Nash

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU-1	Well Installation Date and Time: 6-27-95		Project No. 08519.70
Client: NAVY	Well Development Date and Time: 7/17/95	Logged by: JMN	Checked by: WRD
Well/Site I.D.: OLD-01-21C ~~01-07-03~~	Weather: Cloudy ≃ 83°	Start Date: 7/17/95	Finish Date: 7/18/95
Volume of Drilling Fluid Lost (gal.) 315	Volume of Water in Well and Filter Pack (gal.) 14.56	Start Time: 0810	Finish Time: ~~1130~~ 1355

Installed Depth From Top of Well Casing to Bottom of Well: 51'

Initial Depth to Water (ft): 15.59'

Initial Depth to Well Bottom: 49.92'

Water Level during Initial Pumping/Purging (ft): 17.60'

Depth to Water at Termination of Pumping/Purging (ft): 15.36'

Depth to Well Bottom at Termination of Pumping/Purging (ft): 50.14'

	TIME	TEMP.	pH	Conductivity	Approximate Pumping Rate (gal/min)	Turbid. NTU
7/17/95 BEGINNING OF WELL DEVELOPMENT	0833	25	5.47	132	1.5	>20[illegible]
7/18/95	1101	26	5.59	146	3	[illegible]
	1124	26	5.50	148	3	>20[illegible]
	1150	26	5.28	146	3	13[illegible]
	1207	26	5.32	142	3	10[illegible]
END OF WELL DEVELOPMENT	1233	26	5.26	140	3	75

NOTES: (Include physical character of removed water, type & size of pump, volume of water removed.)

Honda WB15 SD 588955

550 gal

Well Developer's Signature John Nader

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OCD-UL-21C ~~UL-07-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):

Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):

Depth to Well Bottom at Termination of Pumping/Purging (ft):

	TIME	TEMP.	pH	Conductivity	Approximate Pumping Rate (gal/min)	Turbidity NTU
BEGINNING OF WELL DEVELOPMENT	1250	26	5.21	136	3	67.5
	1311	26	5.27	136	3	60.3
	1330	26	5.25	134	3	70.
	1352	26	5.20	132	3	54.
END OF WELL DEVELOPMENT						

NOTES: (Include physical character of removed water, type & size of pump, volume of water removed.)

Well Developer's Signature ______________________

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 06/15/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 07/11/95	Logged by: MN	Checked by: WDD
Well/Site I.D.: OLD-U1-22A ~~U1-08-01~~	Weather: Sunny, ~ 80	Start Date: 7/11/95	Finish Date: 7/11/95
Volume of Drilling Fluid Lost (gal.) 0	Volume of Water in Well and Filter Pack (gal.) 5.32 gal	Start Time: 0815	Finish Time: 1125

Installed Depth From Top of Well Casing to Bottom of Well: 20'

Initial Depth to Water (ft): 15.42' | Initial Depth to Well Bottom: 19.85'

Water Level during Initial Pumping/Purging (ft): 17

Depth to Water at Termination of Pumping/Purging (ft): 15.50 | Depth to Well Bottom at Termination of Pumping/Purging (ft): 19.88

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity µMHOS	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
0817	28.5	5.77	208	>200		~~2.5~~ not much of a rate. Pump not working
0844	30	5.82	241	>200		~~2.5~~
1000	32	6.47	198	96.7		.5
1014	32	6.54	198	17.3		.5
1030	32	6.34	190	24.1		.5
1044	32	6.26	188	46.9		.5

END OF WELL DEVELOPMENT

Notes: (include Physical character of removed water, type and size of pump, volume of water removed.)

Centrifugal Pump Honda WH15X SD# 000217
Centrifugal Pump Honda WB15 SD# 888955 (started @ 0950)
Stopped pump between sample to let well recharge
55 gal

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

NTC_Orl.POP
MVL07.94

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-J1-22A ~~U1-08-01~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.) 1	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1057	32	6.24	190	10.95	~~10.95~~ 4MN	.5
1123	32	6.25	188	19.6		.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ____________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/15/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/11/95	Logged by: MH	Checked by:
Well/Site I.D.: OLD-U1-23B ~~U1-03-02~~	Weather: Sunny ≃ 80	Start Date: 7/11/95	Finish Date: 7/11/95
Volume of Drilling Fluid Lost (gal.) 0	Volume of Water in Well and Filter Pack (gal.) 12.87'	Start Time: 0819	Finish Time: 0950

Installed Depth From Top of Well Casing to Bottom of Well: 40'

Initial Depth to Water (ft): 15.47' | Initial Depth to Well Bottom: 39.66'

Water Level during Initial Pumping/Purging (ft): 23.12'

Depth to Water at Termination of Pumping/Purging (ft): 15.51' | Depth to Well Bottom at Termination of Pumping/Purging (ft): 39.65'

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity µMHOS	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
0830	31	5.01	260	>200		2.5
0848	29°	5.01	199	>200		2.5
0902	28	4.93	190	67.9		2.5
0915	28	4.87	190	184.5		2.5
0927	28	4.93	188	31.9		2.5
0930	28	4.94	188	23.5		2.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Centrifugal Pump Honda WB15 SD#888955

125 gal

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-01-23B ~~01-08-02~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0938	28	4.94	187	27.9		2.5
0946	28	4.95	186	22.0		2.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ____________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

1/3

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/16/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/11/95	Logged by: MH	Checked by: WDD
Well/Site I.D.: ~~U1-08-03~~ ~~OLD-U1-23A~~ OLD-U1-24C	Weather: Sunny ≈ 80	Start Date: 7/11/95	Finish Date: 7/11/95
Volume of Drilling Fluid Lost (gal.) 0	Volume of Water in Well and Filter Pack (gal.) 17.80 gal	Start Time: 0817	Finish Time: 1230

Installed Depth From Top of Well Casing to Bottom of Well: 70'

Initial Depth to Water (ft): 15.56 | Initial Depth to Well Bottom: 69.38'

Water Level during Initial Pumping/Purging (ft): 15.59'

Depth to Water at Termination of Pumping/Purging (ft): 15.59' | Depth to Well Bottom at Termination of Pumping/Purging (ft): 69.39

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity μmhos	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
0823	26	6.10	370	>200		1 gal/min
0841	26	5.55	163	>200		1
0858	26	5.55	115	>200		1
0922	26	5.54	98	>200		1
0932	26	5.53	90	>200		1
0949	26	5.47	82	>200		1

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Waterra SD#001312

275 gal

Well Developer's Signature Mar Hawes

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

2/3

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: ~~OLD-01-24C~~ 01-08-03	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft): | Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft): | Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1008	28	5.60	182	>200		1.5
1025	28	5.53	180	>200		1.5
1053	29	5.55	80	>200		1.5
1116	30	5.56	78	>200		1.5
1140	28	5.29	72	>200		1.5
1155	28	5.32	70	>200		1.5
1205	28	5.09	70	>200		1.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

275 gal rem

Well Developer's Signature __________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

3/3

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OCD-31-24/C ~~11-08-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft): | Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft): | Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1220	29	5.18	72	>200		1.5
1229	29	5.17	70	>200		1.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/13/95		Project No. 8519.70
Client: Navy	Well Development Date and Time: 7/10/95 0945	Logged by: MH	Checked by: WRQ
Well/Site I.D.: ~~U1-09-01~~ OLD-01-25A	Weather: Sunny ≈ 90°	Start Date: 7/10/95	Finish Date: 7/10/95
Volume of Drilling Fluid Lost (gal.) 0	Volume of Water in Well and Filter Pack (gal.) 7.85 gal	Start Time: 1025	Finish Time: 1337

Installed Depth From Top of Well Casing to Bottom of Well: 20'

Initial Depth to Water (ft): 12.68'

Initial Depth to Well Bottom: 19.22'

Water Level during Initial Pumping/Purging (ft): 18'

Depth to Water at Termination of Pumping/Purging (ft): 12.76'

Depth to Well Bottom at Termination of Pumping/Purging (ft): 19.22'

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity μMHOS	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
1038	26	4.61	200	>200		1.25
1054	27	4.53	170	~~>2~~ 181.6		1.25
1112	26	4.27	170	>200		1.25
1232	28	4.27	172	152.7		1.25
1245	27.5	4.30	168	113.7		1.25
1303	27.5	4.10	172	45.7		1.25
1323	27	4.24	170	27.3		1.25

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Centrifugal pump Honda WB15X SD 000217

165 gal

Well Developer's Signature [signature]

FIGURE 4-3 EXAMPLE WELL DEVELOPMENT RECORD	PROJECT OPERATIONS PLAN NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-01-25A ~~01-09-01~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1334	27	4.12	170	23.1		1.25

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3 EXAMPLE WELL DEVELOPMENT RECORD	PROJECT OPERATIONS PLAN NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/13/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/10/95 0945	Logged by: MA	Checked by: WAO
Well/Site I.D.: ~~GED-20~~ ~~U1-09-02~~ OCD-U1-26	Weather: Sunny ≈ 90°	Start Date: 7/10/95	Finish Date: 7/10/95
Volume of Drilling Fluid Lost (gal.) NA	Volume of Water in Well and Filter Pack (gal.) 14.14 gal	Start Time: 1025	Finish Time: 1414

Installed Depth From Top of Well Casing to Bottom of Well: 50'

Initial Depth to Water (ft): 17.42' | Initial Depth to Well Bottom: 49.23'

Water Level during Initial Pumping/Purging (ft): 23.00'

Depth to Water at Termination of Pumping/Purging (ft): 17.65 | Depth to Well Bottom at Termination of Pumping/Purging (ft): 49.76

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity μmhos	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
1040	26	6.13	245	>200		2
1100	25.5	5.97	189	>200		2
1121	25.5	5.85	132	>200		2
1140	25.5	6.05	160	>200		2
1209	25.0	6.00	108	>200		2
1240	26.0	5.67	115	178.6		2
1310	26.0	5.80	110	133.8		2

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Centrifugal pump Honda WB15 SD# 888955

330 gal

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

NTC_Orl.POP
MVL07.94

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD-U1-26B ~~U1-09-07~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1327	26.5	5.45	100	189.4		2

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project: BRAC NTC Orlando OU1	Well Installation Date and Time: 6/12/95		Project No. 8519.70
Client: NAVY	Well Development Date and Time: 7/10/95 0945	Logged by: MX	Checked by: [illegible]
Well/Site I.D.: ~~U1-09~~-03 OLD U1-27C	Weather: Sunny ≈ 90°	Start Date: 7/10/95	Finish Date: 7/10/95
Volume of Drilling Fluid Lost (gal.) 273	Volume of Water in Well and Filter Pack (gal.) 16.35 gal	Start Time: 1025	Finish Time: 1940

Installed Depth From Top of Well Casing to Bottom of Well: 63'

Initial Depth to Water (ft): 17.38'

Initial Depth to Well Bottom: 62.48'

Water Level during Initial Pumping/Purging (ft): 26.53

Depth to Water at Termination of Pumping/Purging (ft): 17.67

Depth to Well Bottom at Termination of Pumping/Purging (ft): 62.40'

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity NMHOS	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
1030	25	6.22	320	>200		.75
1050	25	6.14	177	>200		.75
1114	25	6.03	142	>200		.75
1130	25	6.12	138	>200		.75
1148	24.5	6.25	138	>200		.75
1206	25	6.22	136	>200		.75
1248	25	6.41	162	>200		.75

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Waterra Pump SO# 001312

770 gal

Well Developer's Signature [signature]

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: ~~01-09-03~~ OCD-01-27C	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft): | Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft): | Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature °C	pH	Conductivity µMHOS	Turbidity NTU	Other	Approximate Pumping Rate (gal/min.)
1314	25	6.22	127	>200		.75
1348	25	6.04	119	>200		.75
1407	25	6.15	142	>200		.75
1426	25	6.03	126	>200		.75
1445	26	6.09	120	>200		.75
1508	29	6.08	125	>200		1.00
1525	29.5	5.98	130	>200		1.00

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ____________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OLD U1-27C ~~U1-09-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft): | Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft): | Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1537	30	5.92	125	>200		1.00
1600	29	6.47	170	199.5		1.00
1627	30	6.03	123	159.8		1.00
1658	30	~~6.02~~ 6.15	132	155.0		1.00
1722	31.5	5.90	120	123		1.00
1750	30	5.98	110	178.6		1.00
1815	30	6.02	110	103.4		1.00

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: OCD-U1 27C ~~U1-09-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):

Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):

Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
1845	30	6.00	110	91.9		1.0
1914	30	5.94	110	84.0		1.0
1939	30	5.93	110	81.6		1.0

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Well Developer's Signature ______________________

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: ~~CCD-U1-27C~~ ~~U1-09-03~~	Weather:	Start Date:	Finish Date: 7/14/95
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time: 1435

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft): | Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft): | Depth to Well Bottom at Termination of Pumping/Purging (ft):

BEGINNING OF WELL DEVELOPMENT

Time	Temperature	pH	Conductivity	Turbidity	Other	Approximate Pumping Rate (gal/min.)
0936	31	5.71	128	>200		.5
1009	31	6.07	122	>200		.5
1044	31	6.05	121	164.4		.5
1152	31	5.90	118	110.3		.5
1245	32	6.03	130	92.4		.5
1332	34	6.03	122	81.5		.5
1345	32	6.12	142	81.4		.5

END OF WELL DEVELOPMENT

Notes: (Include Physical character of removed water, type and size of pump, volume of water removed.)

Hand WH 15x SD 000217

Well Developer's Signature ______

FIGURE 4-3

EXAMPLE WELL DEVELOPMENT RECORD

PROJECT OPERATIONS PLAN

NAVAL TRAINING CENTER
ORLANDO, FLORIDA

8519-03 940321WEM

WELL DEVELOPMENT RECORD

Project:	Well Installation Date and Time:		Project No.
Client:	Well Development Date and Time:	Logged by:	Checked by:
Well/Site I.D.: ~~GCD-U1-27C~~ ~~U1-09-03~~	Weather:	Start Date:	Finish Date:
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.)	Start Time:	Finish Time:

Installed Depth From Top of Well Casing to Bottom of Well:

Initial Depth to Water (ft):	Initial Depth to Well Bottom:

Water Level during Initial Pumping/Purging (ft):

Depth to Water at Termination of Pumping/Purging (ft):	Depth to Well Bottom at Termination of Pumping/Purging (ft):

	TIME	TEMP.	pH	Conductivity	Approximate Pumping Rate (gal/min)	Turb
BEGINNING OF WELL DEVELOPMENT	1402	34	5.98	132	.5	76
END OF WELL DEVELOPMENT						

NOTES: (Include physical character of removed water, type & size of pump, volume of water removed.)

Well Developer's Signature John Nash

WELL DEVELOPMENT RECORD

Project: NTC ORLANDO	Well Installation Date and Time: 7-31/96 1045		Project No. 08519.10
Client: South DIV.	Well Development Date and Time: 8/12/96 - 0800	Logged by: WDO	Checked by: PGM
Well/Site I.D.: OLD-U1-28	Weather: -	Start Date: 8/12/96	Finish Date: 8/12/96
Volume of Drilling Fluid Lost (gal.) NA	Volume of Water in Well and Filter Pack (gal.) 6.4	Start Time: 0940	Finish Time: 1240

Installed Depth From Top of Well Casing to Bottom of Well: 33 ft

Initial Depth to Water (ft): 14.04 ~~17.55~~ PGM	Initial Depth to Well Bottom: 33'

Water Level during Initial Pumping/Purging (ft): *

Depth to Water at Termination of Pumping/Purging (ft): NA	Depth to Well Bottom at Termination of Pumping/Purging (ft): NA

	DATE /TIME	TEMP.	pH	Conductivity	TURB (NTU) ~~Approximate Pumping Rate (gal/min)~~	VOL PURGED (GAL)
BEGINNING OF WELL DEVELOPMENT	8/2/96-0940	27	5.37	140	>200	25
	8/7/96-1711	25.5	5.71	181	>200	65
	8/9/96-1800	NA	NA	NA	>200	95
END OF WELL DEVELOPMENT	8/12/96-1240	26	5.61	NA	>200	155

NOTES: (Include physical character of removed water, type & size of pump, volume of water removed.)

* WELL DEVELOPED IN STAGES OVER EPISODES (8/2, 8/7, 8/9, AND 8/12/96). DEVELOPMENT ACCOMPLISHED BY PUMPING, USING PERISTALTIC PUMP ON 3 OF 4 OCCASIONS AND A SUBMERSIBLE ON 4TH. USING PERISTAL PUMP, WATER LEVEL STABILIZES AT .75 L/MIN. TURBIDITY FAILED TO CHANGE DURING DEVELOPMENT PROCESS.

Well Developer's Signature G. Micol(?) FOR WDO

WELL DEVELOPMENT RECORD

Project: NTC-ORLANDO	Well Installation Date and Time: 7/31/96		Project No. 8519.10
Client: SOUTH DIV	Well Development Date and Time: 8/2/96 -0900	Logged by: WDO	Checked by: PGM
Well/Site I.D.: OLD-U1-29	Weather:	Start Date: 8/2/96	Finish Date: 8/12/96
Volume of Drilling Fluid Lost (gal.)	Volume of Water in Well and Filter Pack (gal.) 6	Start Time: 0900	Finish Time: 1200

Installed Depth From Top of Well Casing to Bottom of Well: 65'

Initial Depth to Water (ft): 17.55

Initial Depth to Well Bottom: NA

Water Level during Initial Pumping/Purging (ft): *

Depth to Water at Termination of Pumping/Purging (ft): NA

Depth to Well Bottom at Termination of Pumping/Purging (ft): NA

	DATE/TIME	TEMP.	pH	Conductivity	TURB (NTUs) ~~Approximate Pumping Rate (gal/min)~~	VOL PURGE
BEGINNING OF WELL DEVELOPMENT	8/2-0924	31	5.28	225	7200	1
	8/2-0940	27	5.37	140	7200	25
	8/7-1833	27	5.5	178	7200	30
	8/7-1848	26	5.8	165	7200	158
	8/9-1700	NA	NA	NA	7200	188
END OF WELL DEVELOPMENT	8/12-1240	NA	NA	NA	<200	255

NOTES: (Include physical character of removed water, type & size of pump, volume of water removed.)

*WELL DEVELOPED BY PUMPING DURING 4 SEPARATE EPISODES. FIRST EPISODE USED PERISTALTIC PUMP. WATER STABILIZED A .75 L/MIN. USED SUBMERSIBLE ON FINAL 3 PUMPING EPISODES. WATER "CLEARED APPRECIABLY" AT FINAL PURGING EPISODE.

Well Developer's Signature G. Mikell FOR WDO